S/M No. :

Training Manual

PRODUCT : DVD Player
MODEL : DVG series

DAEWOO ELECTRONICS CO., LTD.

http : //svc.dwe.co.kr

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1.OVERVIEW

1.INTRODUCTION

1.1 Who Needs DVD?

As the compact disc has become so successful and fulfils a wide range of applications, why is a new technology being introduced and who needs it? Major companies from different industries have invested heavily in developing DVD.

The Format	Who needs it?
DVD-Video	The **movie industry**, which needs a CD-like disc capable of holding a full length movie of Laserdisc quality video with surround sound audio.
DVD-ROM	The **computer industry**, which needs higher capacity for the increasingly complex multimedia applications which are now being developed. The **entertainment industry** which needs DVD for new video games with better and more realistic video content.
DVD-Audio	The **music industry**, which is looking to a higher quality format with more bits per sample than CD, as well as increased playing time.
DVD-RAM & DVD-R	The **computer** and **consumer electronics industries** which need new recordable and re-writable versions of DVD for data storage and archival.

DVD technology offers an optical disc with a much larger capacity than the compact disc which is available as a family of pre-recorded, recordable and re-writable formats to meet the requirements of the industries mentioned above. DVD is available and the applications exist

1.2 DVD Features

DVD started as the Digital Video Disc but now means Digital Versatile Disc or just DVD. It is a multi-application family of optical disc formats for read-only, recordable and re-writable applications.

The main features of the DVD formats are:

- Backwards compatibility with current CD media. All DVD hardware will play audio CDs and CD-ROMs.
- Physical dimensions identical to compact disc but using two 0.6 mm thick substrates, bonded together.
- Single-layer/dual-layer and single/double sided options.
- Up to 4.7 GB read-only capacity per layer, 8.5 GB per side maximum.

- Designed from the outset for video, audio and multimedia, not just audio.
- DVD-Video for full length movies with high quality video on one disc.
- DVD-ROM for enhanced multimedia and games applications.
- DVD-Audio for higher quality music, surround sound and optional video, graphics and other features.
- All formats use a common file system (UDF).
- Digital and analogue copy protection for DVD-Video built into standard.
- Recordable and re-writable versions are part of the family.

DVD-Video and DVD-ROM hardware and software have been available since 1997. DVD-Audio will be available in 1999. First versions of DVD-R and DVD-RAM have become available during 1998. Higher capacity versions and other re-writable formats will be available in 1999.

1.3 DVD History

DVD started in 1994 as two competing formats, Super Disc (SD) and Multimedia CD (MMCD). DVD now is the result of an agreement by both camps on a single standard to meet the requirements of all the various industries involved.

1994	Hollywood ad hoc committee defined features for movies on 'CD' .
1995	Philips/Sony announce and demonstrate MMCD Toshiba and Warner announce and demonstrate SD
Dec 95	Agreement on a single standard format called DVD.
Sep 96	DVD-ROM and DVD-Video specifications version 1.0 published
Oct 96	Digital copy protection scheme agreed in outline
Nov 96	First DVD-Video players sold in Tokyo
Mar 97	Launch of DVD in seven cities in the USA
Aug 97	DVD available across USA
Oct 97	DVD Consortium becomes DVD Forum and expands membership
Dec 97	First General DVD Forum Meeting - 120 members
Feb 98	DVD-Video version 1.1 and DVD-ROM version 1.01 specifications
Mar 98	DVD Forum adopts DVD-RW as another re-writable format
May 98	Soft launch of DVD in Western Europe DVD Forum announces 7 new members of DVD steering committee
Jun 98	DVD Forum publishes DVD-Audio specification version 0.9
Oct 98	Full launch of DVD in Europe

	1m DVD-Video players sold in USA
Nov 98	4.7 GB DVD-R and DVD-RAM version 1.9 specifications released
Apr 99	DVD-Audio specification ver 1.0 released

1.4 DVD Forum

The DVD Forum was originally called the DVD Consortium and comprised the following 10 members who were responsible for developing the DVD standards and specifications:

- Hitachi
- JVC
- Matsushita
- Mitsubishi
- Philips
- Pioneer
- Sony
- Thomson
- Time Warner
- Toshiba

Seven new members have been added to these to form the DVD Steering Committee:

- IBM Corporation
- Industry Technology Research Institute of Taiwan
- Intel Corporation
- LG Electronics
- NEC Corporation
- Samsung Electronics
- Sharp Corporation

The DVD Forum has been extended to include other companies involved in DVD and now has about 220 members, 12% of which are in Europe. General Meetings of the DVD Forum were held in December 1997 and February 1999 in Tokyo. There are two categories of DVD Forum membership:

- Principal (or 'A') members who can vote at General Meetings
- Associate (or 'B') members who can attend but cannot vote at General Meetings

1.5 DVD Forum Working Groups

The DVD Forum continues to maintain and improve the specifications describing the various standards and to carry out other related work in support of the formats. This work is carried out by a number of working groups.

WG	Chair company	Description	Current version & date
WG1	Toshiba	DVD-Video Create format and develop subset and extensions for other uses such as DVD-RAM, DVD-R and HDTV.	1.11 (May 1999)
WG2	Pioneer	DVD-ROM Create physical specifications for DVD Read-Only Disc.	1.02 (Sep 1999)
WG3	Matsushita	File system Create File Systems for DVD Discs.	
WG4	JVC	DVD-Audio Create format, which meets the music industryv requirements for high-quality audio.	1.0 (Apr 1999)
WG5	Hitachi	DVD-RAM Create the Physical Specifications for the DVD-Rewritable Disc Format.	2.0 (Oct 1999)
WG6	Pioneer	DVD-R Create the Physical Specifications for the DVD-Recordable Disc.	1.9 (Nov 1999)
		DVD-RW Create the Physical Specifications for the DVD Re-Recordable Disc.	0.9 (Oct 1999)
WG9	Toshiba	Copy Protection Assist Copy Protection Technical Working Group (CPTWG)	
WG10	Pioneer	Professional Use Create the application format for broadcasting and industrial uses of DVD	

2.DVD SPECIFICATIONS

2.1 DVD Physical Specifications

The DVD technical specifications are contained in five books A to E published by the DVD Forum. To obtain copies contact Toshiba Corporation, phone: +81 3 3457 2473, fax: +81 3 5444 9430.

Book	Name	Part 1 Physical	Part 2 File System	Part 3 Application	Version
A	DVD-ROM	Read-only	ISO 9660 + UDF	undefined - depends on application	ver 1.01
B	DVD-Video	Read-only	UDF	MPEG-2 video for movies etc	ver 1.1
C	DVD-Audio	Read-only	UDF	high quality audio	ver 0.9
D	DVD-R	Write once	UDF	not defined	ver 1.0
E	DVD-RAM	Re-writable	UDF	not defined	ver 1.0

The table below summarises the physical parameters of DVD and compares them with those of CD and CD-ROM.

Parameter	CD	DVD		Comments
# layers	1	single	dual	see Disc Formats
Substrate thickness	1.2	0.6		mm
# substrates/ sides	1	2		DVD substrates bonded
Track pitch	1.6	0.74		microns
Min pit length	0.83	0.4	0.44	microns
Scan velocity	1.3	3.49	3.84	m/sec
Wavelength (nm)	780	635/650		red laser for DVD
N/A	0.45	0.6		Numerical aperture
Modulation	EFM	8 to 16		EFM is 8 to 17
Error prot'n	CIRC	RSPC		Block protection for DVD

3rd layer ECC	CD-ROM	No	Not needed for DVD
Subcode/Tracks	Yes	No	Not needed for DVD

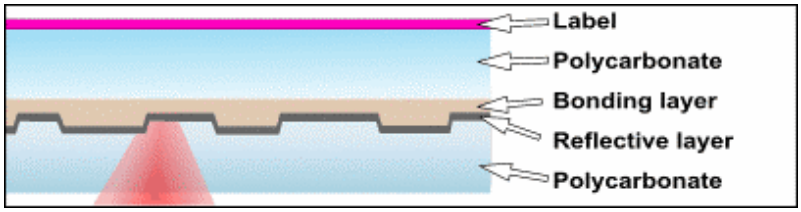
2.2 DVD Disc Formats

All DVD discs comprise a sandwich of two 0.6mm thick substrates. There are four possible read-only formats plus recordable and rewritable formats:

Name	Capacity (GB)	Layers	Sides	Comments
DVD-5	4.7	1	1	Read from one side only
DVD-9	8.54	2	1	Read from one side only
DVD-10	9.4	1	2	Read from both sides
DVD-18*	17.08	2	2	4 layers, read from both sides
DVD-R	4.7/9.4	1	1 or 2	Recordable DVD
DVD-RAM	2.6/5.2	1	1 or 2	Rewritable DVD
DVD-RW	4.7	1	1 or 2	Re-Recordable DVD

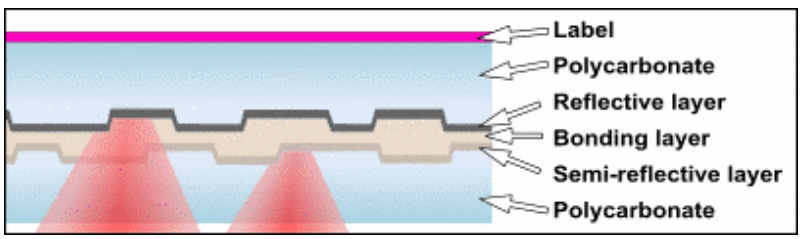
*DVD-18 is extremely difficult to manufacture and there is virtually no replication capacity for this format.

DVD-5 (4.7GB) Single Sided/Single Layer



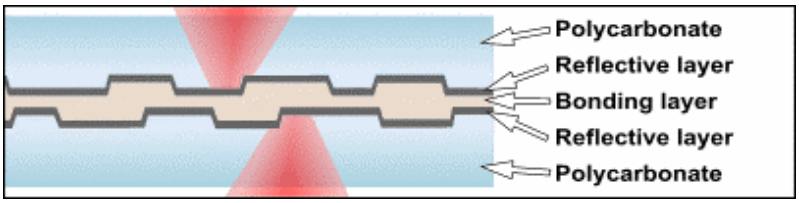
This is the simplest of the family of DVD discs, comprising a single layer with a capacity of 4.7GB. Only one of the two 0.6mm substrates contains data, the other being a blank disc. The two substrates are bonded together to form a 1.2mm thick disc.
Single sided discs can be printed on by any conventional method eg screen printing. Alternatively, the blank substrate can be moulded with an image in its surface and then metalised to make it visible.

DVD-9 (8.5GB) Single Sided/Dual Layer



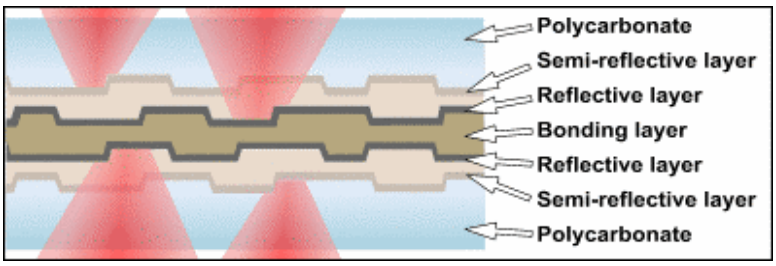
This dual-layer, single sided version has a capacity of 8.5GB which is slightly less than twice the single layer version, to make it easier for the second layer to be read. Pits on both layers are 10 per cent longer than on a DVD-5 or DVD-10 disc.
Each layer is moulded in one substrate, the two substrates being joined with an optically transparent bonding layer. These discs can be printed after bonding in the conventional way.

DVD-10(9.4GB) Double Sided/Single Layer



This disc comprises two sides each single layer. It differs from the DVD-5 version in that both substrates contain data. To read both sides the disc will need to be turned over for most DVD players/readers. The capacity is 9.4GB, twice the single side/single layer version.
Double sided discs cannot be printed except on the hub inside the lead-in area. Labelling is therefore a problem with such discs.

DVD-18 (17.1GB) Double Sided/Dual Layer



This version comprises two sides each with a dual layer format. Both layers of each side must be manufactured on a single polycarbonate substrate using a 2P (photopolymer) process. It has the largest capacity of the family but is the most difficult and complex to manufacture. Four stampers are needed, two fitted to standard DVD presses, the other two used to create pits in the photopolymer.

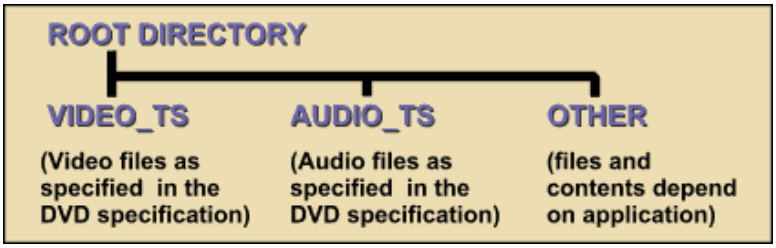
2.3 DVD File System

A new file system was chosen for DVD which would suit both read-only and writable versions. This file system is a subset of UDF (Universal Disk Format) called micro UDF

(M-UDF). The main characteristics of UDF are:

- Robust file exchange
- System & vendor independent
- Writable & read-only media
- Based on ISO 13346

UDF is being extended to provide the necessary features for both write-once and rewritable discs. A combination of UDF and ISO 9660 (known as UDF Bridge) is used on some DVD discs to provide compatibility with existing operating systems, including Windows95. Applications can access the data files using either ISO 9660 or UDF file structures, but the use of UDF is recommended.



DVD-Video discs use only UDF (not ISO 9660) with all required data specified by UDF and ISO 13346 to allow playing in computer systems. The DVD-Video files must be no larger than 1 GB in size and be recorded as a single extent (ie in one continuous sequence). The first directory on the disc must be the VIDEO_TS directory containing all the files. All filenames are 8.3 format. All other files not included in the DVD-Video specification will be ignored by DVD-Video players.

DVD-Audio discs will also only use UDF and will use the AUDIO_TS directory.

DVD-ROM discs will use UDF (plus ISO 9660). However Windows95 was not designed to read UDF but can read ISO 9660. The UDF Bridge specification does not explicitly include the Joliet extensions for ISO 9660 which are needed for long filenames. Most current Premastering tools do not include the Joliet extensions but it is expected that this feature will be added in due course. Windows98 does read UDF so these systems have no problem with UDF or long filenames.

2.4 Copy Protection for DVD

Copy protection comprises both digital and analogue techniques.

2.4.1 CSS Digital Copy Protection

The Content Scrambling System (CSS) is used to scramble the audio/video data on a DVD-Video disc. Each video title set (VTS) can be selectively scrambled using a unique

key. The Disc key and Title keys (one per VTS) are stored on the disc in encrypted form. In the decoder, the original keys are obtained by decryption and used to descramble the data. Data other than audio/video is not encrypted. For DVD-ROM drives, the MPEG-2 decoder challenges the drive and receives the necessary keys for decryption. This ensures that only approved hardware/software can be used.

The keys used should be unique for every disc title and are encrypted by the CSS Licensing Authority and, usually, the scrambling is carried out during glass mastering. Security is vital and the keys used plus the encryption algorithms must be kept secret. Only those companies involved in designing hardware and software for CSS encoding and/or decoding need information on the algorithms and systems used.

CSS II, a variant of CSS, is being developed for DVD-Audio discs.

2.4.2 Macrovision Analogue Copy Protection

The Macrovision Analogue Protection System (APS) is based on Macrovision version 7.0 and is used to distort the composite video output to prevent recording and playback on VHS. This does not extend to RGB or YUV outputs for which new methods are required and are currently being investigated.

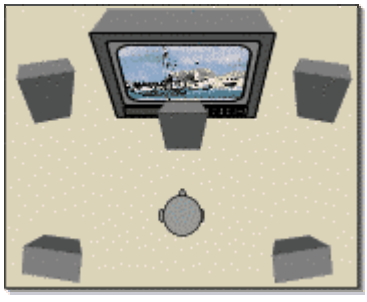
Adding APS to a DVD-Video disc requires the content owner to become licensed by Macrovision and the authoring studio to set a flag to enable APS in the player.

The DVD Forum Copy Protection Working Group (CPTWG) is currently studying new methods to prevent copying and piracy. Digital Watermarking proposals from various companies are also being evaluated for DVD-Video and DVD-Audio discs.

3 DVD VIDEO

3.1 General Features

3.1.1 Introduction to DVD-Video



DVD-Video has been designed to meet the requirements of the movie industry, in particular for a complete movie on a single 'compact disc'. Results show that the use of MPEG-2 video can give superlative results, far better than VHS and often better than Laserdisc. DVD-Video also offers full surround sound, subtitling, a choice of display formats and user interaction for non-linear video applications.

The DVD-Video specification (currently version 1.11) is maintained by the working group WG1 which comprises a number of task groups concerned with both read only and recordable disc formats.

DVD-Video players were launched in Japan in November 1996 and in the USA in March 1997. It has already become a mainstream product in the USA and the market in Europe is growing fast.

DVD-Video has already become the industry standard format for distribution of movies and other video material for the consumer and corporate markets. When a recordable version is available DVD-Video is set to replace the VHS for home video recording and playback of pre-recorded video.

3.1.2 DVD-Video Requirements

The Hollywood based Motion Picture Studio Advisory Committee defined the following requirements for the DVD-Video format:

- 135 minutes on one side of a single disc (covering 99% of all movies).
- Video resolution better than Laserdisc (LD).
- CD quality surround sound for true home cinema listening.
- 3 to 5 languages (audio) per title on one disc
- 4 to 6 subtitles per title on one disc
- Pan-scan, letterbox and widescreen formats
- Parental lockout features
- Copy protection
- Compatibility with existing CDs
- Chapter division and access (like Video CD)
- Manufacturing cost similar to current CD costs.

The Video CD format was studied, but was rejected as it could not offer the necessary combination of quality and playing time, hence the need for a new higher capacity disc format that has been realised in DVD. The above requirements have all been met in the DVD-Video specification.

3.1.3 DVD-Video Features

The DVD-Video specification provides the following features:

- 133 minutes of high quality MPEG-2 encoded video with multi-channel surround sound audio.
- The choice of widescreen, letter box and pan & scan video formats.
- Audio in up to 8 languages
- Subtitles for a further 32 languages
- Menus and program chains for user interactivity

- Up to 9 camera angles to give the user more choice
- Digital and analogue copy protection
- Parental control for protection of children

The DVD-Video specification is based on a pre-recorded DVD (DVD-ROM) with UDF Bridge file system. A DVD-Video can therefore be a DVD-5, DVD-10 or DVD-9 disc depending on the playing time required and other factors. For overall playing times longer than 133 minutes (including additional content), a DVD-9 offers a solution. A DVD-10 is more useful where widescreen and pan & scan versions are required on the same disc. The use of the DVD-10 format is not recommended for longer playing times, as the disc needs to be flipped to play the other side.

3.1.4 DVD-Video Data Streams

To meet the Hollywood requirements, DVD-Video discs are designed to store audio visual sequences each comprising data streams of four types of data:

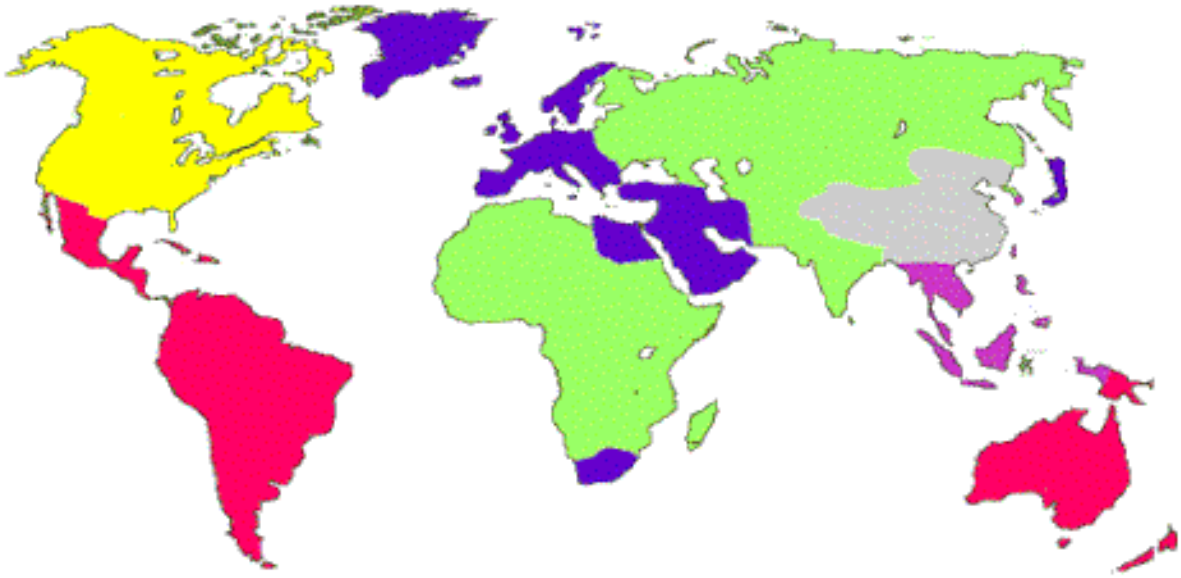
Data type	No. of Streams	Max data rate (Mbps)	Coding
Video	1	9.08	MPEG-1 or MPEG-2 video, including both video sequences and video stills (eg for menus and slide shows).
Audio	up to 8	6.144	A number of audio formats are available for both stereo and surround sound with the provision for multiple languages.
Subpictures	up to 32	3.36	2 bits/pixel run length encoded subpictures which overlay the video for subtitles.
Navigation	1	-	Program Chains to provide interactivity

3.1.5 Regions & Copy Protection

DVD-Video discs may be region coded to prevent eg a US disc playing on a European player and vice versa. This allows titles to be distributed in different parts of the world at different times. A total of six regions (or locales as they are called) have been defined to cover all countries.

Region 1	USA, Canada
Region 2	Europe, Middle East, South Africa, Japan
Region 3	Southeast Asia, Taiwan

Region 4	Central America, S. America, Mexico, Australia, New Zealand
Region 5	Russian federation, Africa (part), India, Pakistan
Region 6	China



All players and PCs with DVD must implement region coding, but not all discs need to be region coded.

Titles can also be copy protected using the CSS (Content Scrambling System) which scrambles the data and Macrovision analogue copy protection (APS) which prevents copying to VHS tape.

3.2 Video Features

3.2.1 Playing Time

A single sided (DVD-5) DVD-Video disc will hold nominally 133 minutes of high quality MPEG-2 encoded video, together with three surround sound audio channels and four subtitle channels. (Without video compression one DVD-5 disc would hold only about 3 minutes of video.) For a dual layer disc (DVD-9) this increases to 240 minutes. A double sided disc (DVD-10) will hold slightly more at 266 minutes, but the disc needs to be turned over to play the other side.

Unlike audio CDs the playing time is not fixed but can vary. Longer playing times mean lower average bit rates and lower video quality, while shorter playing times allow higher bit rates and higher quality. The use of MPEG-1 video allows more playing time at the expense of quality. More or fewer audio channels or different audio bit rates also

affect the video bit rate and/or playing time.

The maximum bit rate is 9.8 Mb/s for video, audio and subpictures (the overall maximum, including control information, being 10.08 Mb/s). For a playing time of 133 minutes, the average bit rate is 4.7 Mb/s. The average video bit rate available depends on the number of audio streams and the encoding used, but should be close to 4 Mb/s for high quality results.

3.2.2 Video Encoding

Video can be encoded to either MPEG-2 or MPEG-1 for DVD-Video. These are summarised in the following chart:

	MPEG-2	MPEG-1
NTSC resolutions (horizontal x vertical)	720 x 480 704 x 480 352 x 480 352 x 240	352 x 480 351 x 240
PAL/SECAM resolutions (horizontal x vertical)	720 x 576 704 x 576 352 x 576 352 x 288	352 x 576 352 x 288
Variable Bit Rate (VBR), Constant Bit Rate (CBR)	VBR or CBR	CBR
PAL/SECAM Frame rate	25 fps	
NTSC frame rate (on disc)	24 or 30 fps	

VBR, variable bit rate, encoding allows higher image quality at a lower average bit rate by using more data to encode those parts of a video sequence which are more complex and do not compress well.

Using CBR, constant bit rate, encoding, the video data rate must be high enough to encode all the video well. For short videos where disc capacity is not an issue CBR, at as high a bit rate as possible, is the better choice.

MPEG-2 encoding was designed to encode full CCIR 601 digital signal at the full resolution of 720 x 480 (NTSC) or 720 x 576 (PAL/SECAM). MPEG-2 provides for both VBR and interlaced display as used for broadcast television signals and allows a compression ratio of up to 40:1.

MPEG-1, also used for Video CD, gives even longer playing time but at a lower quality.

Since MPEG-1 does not allow for interlaced display, the image resolution available is reduced to 352 x 240 (NTSC) or 352 x 288 (PAL/SECAM). MPEG-1 is also restricted to constant bit rate (CBR).

For most purposes, MPEG-2 will be used for maximum quality. MPEG-1 is available where playing time is more important than quality.

3.2.3 PAL and NTSC Frame Rates

DVD-Video can comprise either PAL/SECAM or NTSC video material at frame rates of 24, 25 or 30 fps.

PAL/SECAM video uses a frame rate of 25 fps (frames per second). Source video material will be at this frame rate. Film material will have a frame rate of 24 fps and is usually played back at 25fps (to avoid frame rate conversion) and the audio is pitch corrected before the encoding begins.

NTSC video uses a frame rate of 30 (actually 29.97) fps which is identical to NTSC video material. Film material is usually converted from 24 to 30 fps by a

'3/2 pulldown' whereby frames are repeated to convert the 24fps film to 30fps video. However this is not necessary for DVD since the player can carry out the frame rate conversion. Therefore the video can be stored on disc at 24fps and displayed by the player at 30 fps. The encoder embeds MPEG-2 repeat_first_field flags into the video stream to make the decoder perform 3/2 pulldown.

The result is that both PAL and NTSC versions of the same movie will comprise the same number of frames but as PAL frames are larger than NTSC frames they are likely to require more data rate for the same quality.

Some players may convert from PAL to NTSC or NTSC to PAL, but most NTSC players only play NTSC. PAL/SECAM players will play NTSC but require a NTSC TV/video monitor or will convert the NTSC to PAL. Therefore NTSC titles (with no region coding set) will play on PAL (ie European) and NTSC players, while PAL titles will play only on PAL players.

3.2.4 Picture Quality

Quality and resolution are better than Laserdisc and Video CD and playing time is much longer than HQ-VCD as shown below.

Feature	Laserdisc	Video CD	SVCD	DVD-Video
Encoding format	Analogue composite	MPEG-1 (CBR) component	MPEG-2 (VBR) component	MPEG-2 (VBR) component
Image size		352 x 240/288	480 x	720 x 480/576

(max)			480/576	
Video Bitrate	-	1.15 Mb/s	2.6 Mb/s (ave)	3.5 Mb/s (ave)
Quality	good	fair	good	very good
Audio channels	2 to 5.1	2	2	5.1
Languages	1	1	2 stereo or 4 mono	up to 8
Playing time	60 mins	74 mins max	37 mins at max bit rate	133 mins nominal

Laserdisc stores analogue video which is composite encoded, so will suffer from noise and other defects due to imperfections on the disc, but otherwise can offer high quality video that is close to the best that can be achieved from broadcast TV. Playing time is 60 minutes maximum per side.

Video CD is a CD-ROM format that uses MPEG-1 so is limited in playing time and video quality. Movies have been released on Video CD, but need 2 discs for a two hour movie. SVCD (Super Video CD) makes use of VBR MPEG-2 to increase the video quality, but playing time is reduced so that a movie will require three discs not one.

3.2.5 Video Screen Formats

The aspect ratio of traditional TV pictures is 4:3 (horizontal:vertical) while movies are generally a wider aspect ratio, up to 2.35:1. A compromise format, 16:9, is now in use for widescreen TVs and, in Europe in particular, for an increasing number of television programmes.

DVD-Video discs can contain video suitable for either 4:3 or widescreen TVs. A total of three screen formats are available.

- Widescreen, which is only suitable for a widescreen TV display, where a 16:9 image is displayed full screen.
- Letterbox, where the full widescreen image is displayed but leaving black bars at the top and bottom of the screen.
- Pan & Scan where a widescreen movie is displayed as a 4:3 image which is narrower than the original.

16:9 source video is anamorphically squeezed (because the image needs to conform to the 4:3 format on disc, there being the same number of pixels available per line for both 4:3 and 16:9 images) to 4:3 before MPEG-2 encoding, then displayed as letterbox or pan & scan on a normal TV or full size on a widescreen TV. A 16:9 image will comprise pixels that are not square, due to the anamorphic squeezing. Alternatively, a pan & scan version can be encoded on disc for display on normal TVs.

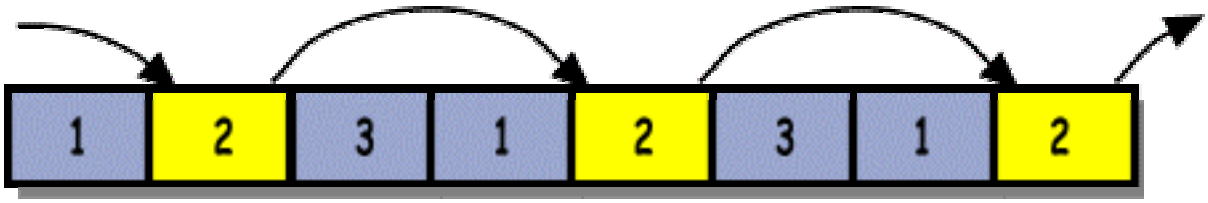
The range of on-disc and display formats are listed below.

On-disc format	Resultant display	
	4:3 display	16:9 display
4:3 full frame	4:3 full screen	4:3
4:3 letterbox	4:3 letterbox	16:9 full screen
16:9 no pan & scan data	4:3 letterbox	16:9 full screen
16:9 with pan & scan data*	4:3 letterbox or pan & scan	16:9 full screen

* This format requires data to define on a frame by frame basis which part of the image should be displayed. As yet there is probably no title available which use this format. Instead, DVD-10 discs are often used to offer both pan & scan and widescreen versions on one disc.

3.2.6 Camera Angles

DVD-Video discs offer the possibility to include up to 9 different camera angles which can be seamlessly selected by the user. The different but parallel sequences (angles) are interleaved on the disc to allow rapid seeking between them. The result is that the overall data rate available is somewhat reduced to allow for the seek time needed to allow the laser to jump to the next part of each sequence or angle. The reduction in data rate depends on the number of angles included.



The above example shows how three angles are interleaved within the video stream (with the audio and any subpictures). Any particular angle (2 in this example) is played by jumping across the other two. The need to re-seek at intervals does reduce the overall bit rate.

Multiple camera angles can be seamless or non-seamless. Non-seamless transitions happen instantly but there is a break in playback. Seamless transitions are slower but there is no break in playback.

3.2.7 Stills, Fast and Slow Play

MPEG-2 still images can be included e.g. copyright notices, menus or slide shows. These stills are encoded as single I-frames and save disc space if the image is not moving or changing.

Also video sequences can be displayed as stills using the player's still-frame control. A video sequence can also be caused to freeze automatically by being programmed to do so. The quality of still frames depends on the video material. If a video sequence with movement is paused, any movement between the two fields will prevent the display of a perfectly still image. An example is a person walking or moving their arms. Some players allow a single field to be displayed (but repeated to give a complete frame) to avoid this problem, although the resolution is reduced.

Encoding problems can affect the display of stable still frames. For example incorrect field dominance can produce a still frame which comprises fields from two successive frames. The result will be particularly disturbing at a cut between two scenes. Video from film will not exhibit this problem as both fields were shot at the same time.

Player controls also allow the video to be played in slow motion (forward motion is relatively smooth as every frame is played but reverse motion plays only the I-frames) and fast forward or reverse (by displaying I-frames only).

3.2.8 Subpictures

Subpictures are graphics images which can be overlaid on top of video stills or sequences. They can be any height and width up to full screen (720 pixels by 480 or 576 lines) with 4 colours per pixel and are used for subtitles and menus.

- Subtitles provide the display of text in any of up to 32 languages to complement

the audio language channels. The text is stored on disc as subpictures rather than closed caption encoded characters. This is a more flexible solution which accommodates any character set. The three colours available (plus transparent) can be used to soften/anti-aliase the edge of the text characters and/or to make the text more readable against a varying background.

- Menus comprise MPEG stills with overlaid subpictures for highlighting menu buttons or for providing additional text/graphics. See Interactivity.

Subpictures can be changed each frame, may fade in/out, wipe in or scroll up and down the screen.

3.3 Audio Features

3.3.1 Audio Encoding

DVD-Video discs can carry up to 8 streams of audio using a number of non-compressed and compressed audio coding methods. Each audio stream can contain from 2 (stereo) to 6 (surround sound) channels depending on the source material available. Multi-channel audio will be down-mixed to stereo in players where there is no surround sound decoder. The number of streams available will depend on the number of channels used per stream, the coding method used and the video bit rate needed.
Normally, when used with video, a compressed format will be used. Audio coding formats available for DVD-Video include:

- Dolby Digital
- MPEG-1 & MPEG-2
- LPCM
- DTS

3.3.2 Audio for PAL and NTSC areas

The DVD-Video specification defines the use of different audio encoding methods for PAL/SECAM and NTSC areas. The use of these is summarised in the table.

	Mandatory	Optional
NTSC disc:	Linear PCM or Dolby AC-3	Linear PCM, Dolby Digital, MPEG or others

PAL/SECAM disc:	Linear PCM or MPEG-1 or MPEG-2 or Dolby AC-3	Linear PCM, Dolby Digital, MPEG or others

Note that it is no longer mandatory to include MPEG audio on a PAL/SECAM disc. If MPEG-2 is used it should be possible to play it using a MPEG-1 decoder.
Players for PAL/SECAM areas should be capable of decoding LPCM, Dolby Digital and MPEG and provide stereo outputs as a minimum.

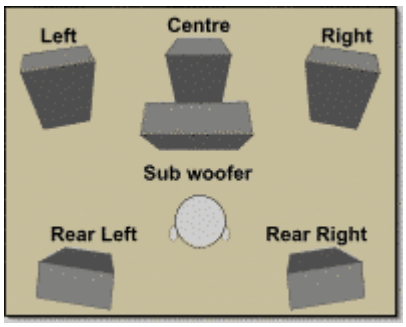
3.3.3 Multi-language Audio

At least three surround sound channels are possible while maintaining sufficient data for the video if either Dolby Digital or MPEG-2 encoding are used. Three examples for implementing multiple languages are shown in the table with the corresponding bit rates needed.

Option	Description	Data rate
1	1 surround sound channel 3 mono (centre) speech channels	448 + (3 * 128) = 832 kb/s
2	1 surround sound channel 3 stereo speech channels	448 + (3 * 256) = 1,216 kb/s
3	3 surround sound channels	3 * 448 = 1,344 kb/s

3.3.4 Surround Sound

Both Dolby Digital and MPEG-2 allow surround sound on 5.1 channels (up to 7.1 for MPEG-2). The channels are:



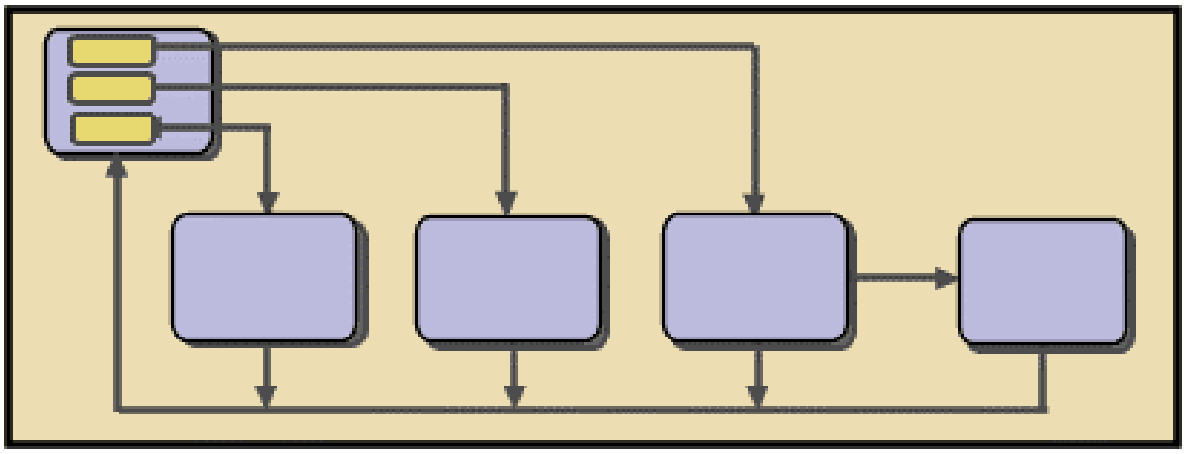
- L, R (Left & Right front)
- C (Centre)
- Ls, Rs (Left & Right surround)
- LFE (Sub-woofer or low frequency effects)

Many movies include one or more surround sound channels usually encoded using Dolby Digital. With the correct surround sound amplifier and speaker setup very realistic results can be obtained. Few players include surround sound decoders but separate decoder/amplifiers are available.

3.4 Interactivity And Interaction

3.4.1 What is Interactivity?

Interactivity is a key element in computer and multimedia applications. For DVD-Video it allows the user to control the presentation of audio visual sequences rather than just viewing it in a linear way. Interactivity can range from simply selecting which chapter in a movie to play to using menus for more complex interaction.



The user interacts with the disc via the player remote control which includes some standard controls and also allows interaction with on-disc controls such as menus.

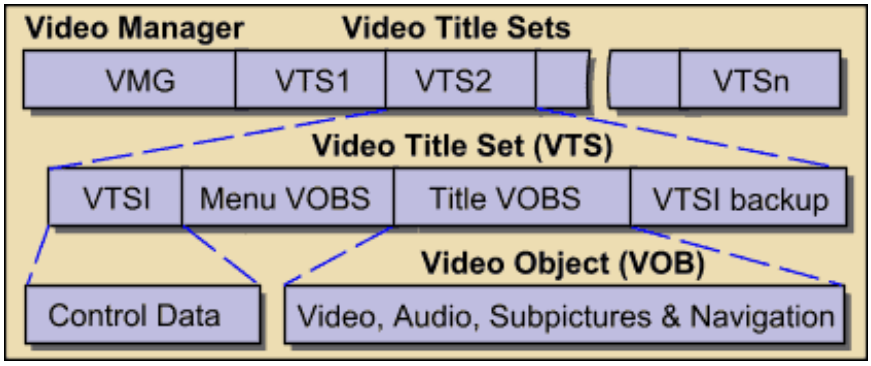
For movies, one or more menus will be provided giving instant access to individual scenes (chapters) in the movie, to select related information such as biographies of the actors and other related video or graphic material.

DVD-Video can be used for presentation material comprising stills and video that can be played in sequence or interactively by selecting a button on a menu.

The range of interactive controls for DVD-Video is not unlimited. It is not possible, for example, to program a DVD-Video application as a complex video game or interactive training program, both of which require much greater programming flexibility than is available for DVD-Video.

3.4.2 DVD-Video Disc Structure

DVD-Video titles consist of a hierarchical structure as illustrated below:



A DVD-Video disc is divided into Video Title Sets, one per title for a multi-title disc. As a minimum there will be one Video Manager (VMG) and one VTS.

Each Video Title Set Information (VTSI) comprises control data and Video Objects (VOBs) for both menus (if present) and titles (stills and video). Each VOB (the fundamental file element of the disc) comprises video, audio, subpictures and navigation data. When a VOB is played the player not only plays the video sequentially but obeys the navigation instructions for displaying menus, getting user selections etc.

Program Chains (PGCs) in VOBs provide the necessary interactivity by means of a simple programming language developed for DVD-Video. PGCs are used to control the playing of video, audio and subtitles in VOBs, to display menus and input and obey user commands.

The following is an example of the files contained in the directory VIDEO_TS for a single title set disc:

Filename	Description
VIDEO_TS.IFO	VMGI file (Video Manager Information)
VIDEO_TS.VOB	VOB file for VMG Menu
VIDEO_TS.BUP	VMGI backup file
VTS_01_0.IFO	VTSI file
VTS_01_0.VOB	Video Object Set for VTS Menu
VTS_01_0.BUP	VTSI backup file
VTS_01_1.VOB	First Title Video Object Set file
VTS_01_2.VOB	Second Title Video Object Set file
. . . . .	. . . . .
VTS_01_n.VOB	Last Title Video Object Set file (n not more than 9)

The audio, video and subpictures for the movie are contained in up to 9 Title VOB files,

where each file is not more than 1GB in size. For a DVD-5 there will be no more than 5 Title VOB files, for a DVD-9 a full 9 will be required if the disc is full.

3.4.3 Player Controls

DVD-Video players include standard controls for the following interactive features:

- Title selection where there is more than one title on a disc
- Chapter selection by number or skipping to the next or previous chapter.
- Bookmarking chapters for access later.
- Fast and slow forward and reverse controls.
- Angle selection giving the user the choice of different views.
- Parental control may be used to exclude certain scenes from a movie.
- Soundtrack selection of up to 8 audio channels
- Subtitle selection of up to 32 subtitles.
- Picture aspect ratio selection

The player remote control will include a number of standard buttons for controlling the player:

- Menu controls: TITLE, MENU, Up, Down, Left, Right, Select
- Video controls: Play, Pause, Stop, Skip (Fwd & Rev), Slow (Fwd & Rev)
- Other controls: Subtitle, Audio, Angle, Setup, Open/Close
- Numerals: 0 to 9

DVD-Video players can be preset eg for the TV/monitor used and the local language for audio and subtitles. These settings will then be used for all DVD-Video discs until changed.

3.4.4 Menus & Navigations

Interactivity on a DVD-Video disc is provided as menus which allow the user to select particular sequences or functions. These menus can be any of the following types:

- Title menu (selected by pressing TITLE button on remote) for selection of any title. Each title can be a particular version of a movie (eg an abbreviated version), a video clip or a trailer.
- Chapter menu (selected by pressing MENU button on remote) for selecting a particular chapter or scene at random. Such a menu will normally indicate the chapter title as well as the number.

- Audio track menu for selecting the audio track to play (eg for the language required).
- Subtitle track menu for selecting the appropriate language subtitles.
- Angle menu for selecting the camera angle required.

There will normally be a main or root menu giving access to the other menus. This menu is accessed by pressing the DVD MENU button on the player remote control.
On-screen menus normally comprise a still MPEG image with a subpicture. A moving MPEG sequence can also be used and audio can be used with menus.
The menu image is divided into button (hotspot) areas which, when selected, will cause a new video sequence, MPEG still or another menu to be displayed. Buttons are usually rectangular and can be highlighted, to show that they have been selected, by overlaying a subpicture over the MPEG still. Subpictures can also be used to display text or other graphics over the still image, giving additional flexibility.
Buttons are selected by the user not by moving a cursor but by using the Up/Down/Left/Right arrow keys on the remote control. When the required button is selected it can be activated by pressing the RETURN key. The three available subpicture colours (the fourth is transparent) can be used to indicate what state the button is in: unselected, highlighted and selected. This provides the necessary feedback to the user. This user interface can be cumbersome but is generally easier to use from a remote control device.

4 DVD-ROM

4.1 Introduction to DVD-ROM

While DVD-Video was the first of the DVD formats to be developed and has received most attention, DVD-ROM is potentially more important and will support a larger range of applications particularly where the CD-ROM capacity is inadequate.

DVD-ROM titles include multi-disc CD-ROM games and reference titles converted to DVD, new versions of CD-ROM titles with additional, high quality MPEG-2 video and applications designed from the outset for DVD.
The computer industry became involved in 1995 and set up the Technical Working Group (TWG) to define the specification for DVD-ROM. The objectives of the TWG are

to understand the technical details of DVD specifications and develop a set of recommendations for current and future forms of computer-based applications. Currently the DVD Forum WG2 is responsible for the DVD-ROM specification which forms the basis for DVD-Video and DVD-Audio as well. The requirements are:

- Single format for computer and TV-based applications
- Backward read compatibility with existing CD-ROMs
- Forward compatibility with future R/W and WORM discs
- A single file system for all content and disc media types
- Low cost drives and discs
- No mandatory container
- Reliable data storage and retrieval
- High on-line capacity
- High performance for both sequential and non-sequential data types

DVD-ROM drives and PCs with DVD capability are now available in Europe as well as the USA and Japan. Generally these will also include MPEG-2 decoders either in hardware or, for high end PCs, in software. They will then be capable of playing DVD-Video discs as well as DVD-ROM applications.

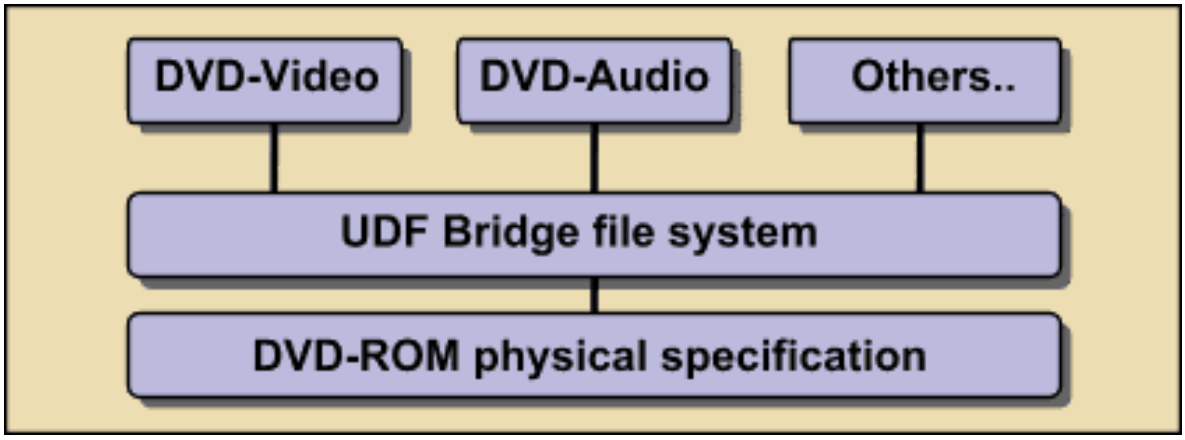
4.2 DVD-ROM Specification

DVD-ROM can be compared with CD-ROM. It provides at least 7 times the capacity so can store much more data for complex multimedia applications and games. It is likely that many such applications will include MPEG-2 video, as used on DVD-Video discs, to give added realism to games and richer content for multimedia applications.
The table below gives a comparison of the major differences between a CD-ROM disc and DVD. Note that 1 GB = 1 billion bytes.

	DVD-5	DVD-9	CD-ROM
Capacity (GB)	4.7	8.5	0.7
File structure used	UDF & ISO 9660		ISO 9660

The DVD-ROM specification is actually the physical specification for all DVD read-only discs together with the UDF file system. Like CD-ROM the DVD-ROM specification does not define how the user data is to be formatted and used. That is left to the application. In contrast the DVD-Video and DVD-Audio specifications define precisely

how the data is formatted. (see DVD formats).



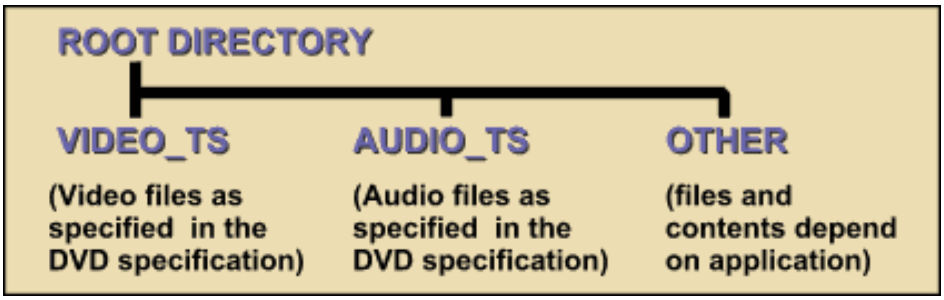
4.3 DVD-ROM File System

Files and directories are a vital part of any computer storage system. Unfortunately a file system was not included in the CD-ROM specification, so a number of different and incompatible file systems are in use, one for each computer operating system. The most commonly used file system is ISO 9660, which is compatible with DOS and Windows.

By contrast all pre-recorded DVD discs use the UDF-Bridge file system. This is a combination of UDF and, for compatibility with existing computer operating systems, ISO 9660. Operating systems designed to support DVD need to provide full support for UDF.

4.3.1 Directory Structure

The DVD Books specify the directory structure shown below. Only the VIDEO_TS and AUDIO_TS directories are specified for DVD-Video and DVD-Audio data respectively.



Other directories may be included for additional data, not specified in the DVD-Video or DVD-Audio Books. These contain the DVD-ROM data for multimedia, games and other computer based applications.

Hybrid titles, with data for more than one application (eg DVD-Video plus a PC game)

will include data in two or more of these directories.

4.4 DVD-ROM Hardware

DVD-ROM titles are designed to play on a specific platform eg PC or Macintosh. These platforms, with appropriate hardware/software, will also play DVD-Video and DVD-Audio discs.

- Most Pentium PCs can be upgraded by adding a DVD-ROM drive and MPEG-2 decoder in order to play DVD discs. Microsoft has designed DVD support in Windows 98, for new PCs, but Windows 95 systems will usually be capable of playing many DVD titles.
- The latest Macintosh Powerbook G3 computers can be upgraded for DVD with the external Apple DVD-Video kit. Apple's MacOS version 8.1 or higher plus QuickTime 3.0 are needed to play DVD discs.

Other platforms are being developed to exploit the capabilities of DVD.

- One such example is Sony's second generation Playstation, which will incorporate a DVD drive, instead of the current CD-ROM drive, and will probably be capable of playing DVD-Video discs.
- The NUON processor, developed by VM Labs, is designed to turn the DVD-Video player into a multimedia computer, facilitating not only playback of DVD-Video discs but also high-performance video games, educational and reference applications, all with highly sophisticated film quality 3-D graphics.

DVD-ROM drives, like CD-ROM drives, are being developed with ever-increasing speeds. Early drives offered 2x speeds, while the latest drives now offer 6x speed, with speeds of up to 8x planned for later in 1999. These faster drives are not necessary for DVD-Video titles (which read data at 1x), but allow faster data transfer for multimedia and games titles.

Single speed DVD-ROM drives have a data transfer rate of approximately 11 Mb/s, which is equivalent to a 9x CD-ROM drive. A 5x drive can theoretically transfer data at 55 Mb/s, equivalent to a 45x CD-ROM data rate. However most 4x and faster DVD-ROM drives read CD-ROMs at 32x maximum. This is because a CD must spin faster than a DVD for the same data rate. For the above example, a 1x DVD spins at 3.49 m/s, while the 9x CD spins at 11.7 m/s.

The table below gives a comparison of the major differences between CD-ROM and DVD-ROM drives. Note that the linear velocity is lower for a DVD than for a CD at the same data rate. Unlike DVD-ROM drives, the highest speed CD-ROM drives are not true CLV (constant linear velocity) but the data rate increases from the ID to the OD, where the maximum data rate is achieved.

	DVD-ROM	CD-ROM
Highest speed drives (announced)	6x	40x
Max data transfer rate (Mbps)	66	2.8 to 6

4.5 MPEG-2 Decoders

An MPEG-2 decoder is needed to play DVD-Video titles plus any MPEG video contained on a DVD-ROM disc. Both hardware and software decoders are available.

- Hardware decoders allow a slower processor, such as a Pentium 133, to be used. Most decoders include a video output, which allows your favourite movies to be watched on a TV instead of the computer monitor.
- Software decoders require a faster processor (at least a 266MHz Pentium II) and a suitable graphics card, but offer a lower cost solution for PCs already equipped with a fast processor.

DVD add-on kits usually comprise a DVD-ROM drive and MPEG-2 decoder board. Software to play DVD-Video discs is also included in the package. Normally this includes an on-screen controller to simulate the remote control of a DVD-Video player.

4.5.1 Microsoft Windows 98 & DirectShow

Microsoft has included DVD capability in Windows 98 for DVD including:

- Reading data sectors from DVD-ROM drives and providing support for the DVD-ROM command set.
- UDF file system support.
- Support for streaming data such as MPEG-2 video and Dolby Digital audio.
- DirectShow (formerly ActiveMovie), which improves compatibility by replacing the old MCI (Media Control Interface) with a new standard interface to play Video Object (VOB) files.
- DirectDraw, which supports the transfer of decoded video streams from an MPEG-2 decoder to the display card via dedicated buses.

- Copyright protection and region coding support for both software and hardware decoders.

4.5.2 QuickTime

QuickTime 3.0 on both Macintosh and Windows platforms, is capable of playing back MPEG-2 video including VOB files, using an existing MPEG-2 decoder.

4.6 DVD-ROM Applications

It is generally believed that DVD will become the predominant storage technology in the computer industry, with worldwide sales of PCs with DVD-ROM drives considerably more than the number of DVD-Video players.

Sales would have been higher, but CD-RW drives are becoming increasingly popular and none of these will play DVD discs. Also there has been an increase in sales of low end PCs for which a DVD-ROM drive is currently too expensive.

DVD-ROM applications can take advantage of the increased capacity of DVD discs and, optionally, make use of DVD-Video's high quality MPEG-2 video and multi-channel audio encoding. There is a wide range of applications for DVD-ROM including:

- Bigger and better games allowing current multi-disc CD-ROM games to be distributed on one DVD-ROM disc. DVD allows the content of six or more CD-ROM discs to be stored on a single disc.
- More extensive multimedia applications, such as encyclopedias, with additional content including higher quality MPEG-2 video and surround sound audio.
- Very large databases and clip-art libraries.
- Hybrid DVD/online titles where the bulk of the data needed (such as video) is stored on the disc and updates are downloaded from the Internet. The Internet can also be used to pay for and unlock software contained on a DVD-ROM disc.
- Dual format titles, which will play on DVD-Video players with limited interactivity and on computers for full interactivity. These include movies with an associated game or multimedia content, which can only be played on a PC or Macintosh.

5 DVD AUDIO

5.1 DVD-Audio Introduction

DVD-Audio is the latest member of the DVD family of pre-recorded optical disc formats, designed for higher quality audio than current CDs. A full version (1.0) was released in April 1999 and discs and players are due in the second half of 1999.

The DVD Forum working group WG4, which has 38 members, has developed the DVD-Audio specification. Its policy is 'to study and listen to what the music industry, represented by ISC, and the general user require of the next-generation high-quality audio format'. Copy protection issues are being dealt with outside WG4 and agreement on the framework to use has been reached.

DVD-Audio will offer a range of new features including even higher quality, surround sound, longer playing times plus additional features which are not available on CDs. DVD-Audio discs will be capable of carrying video, like DVD-Video titles, as well as high quality audio files and include limited interactivity.

Capacity of a dual layer DVD-Audio will be up to at least 2 hours for full surround sound audio and 4 hours for stereo audio. Single layer capacity will be around half these times.

Another requirement, for which Philips has offered a solution (Super Audio CD), is for a disc format which will play on both CD and DVD-Audio players and uses a different coding method.

The music industry is divided, with some music publishers wanting to make use of the features that DVD-Audio will offer and others who believe that DVD-Audio is unnecessary, as CDs currently offer adequate quality for the vast majority of users. Most consumers seem either unaware of DVD-Audio or do not need a new format to replace the CD.

An International Steering Committee (ISC) consisting of the RIAA and the RIAJ with some consumer electronics companies, produced a set of recommendations in May 1996:

- Active Copyright Management Systems (ACMS) in hardware.
- Copyright Identification must include the ISRC.
- Anti-Piracy Measures to include SID codes.
- DVD-Audio discs to carry audio, video and data.
- Conditional Access to additional content on the discs.
- Six audio channels of the highest possible sound quality.
- Accessibility & Disc Functions better than CD players.
- Packaging must not involve a disc caddy.
- Disc durability should be greater than CDs
- One-sided disc is favoured.

Since then the ISC and WG4 have worked together on the DVD-Audio specification and

the development of tools and techniques for creating and Premastering DVD-Audio titles.

5.2 DVD-Audio Specification

The main features of the DVD-Audio specification include:

- High quality multi-channel audio with copy protection
- DVD-Audio players will play CDs
- A wide range of quality levels and channels allowing flexibility for the content owner.
- Extensible to include new technology when available.
- Additional added value content including video, stills, text and menus.
- User friendly navigation system.
- Connection to the Worldwide Web for the latest information supporting the title's content.

5.2.1 DVD-Audio and DVD-AudioV

WG4 has defined two different versions of the DVD-Audio disc format, one for pure audio applications the other for audio with video. Together with DVD-Video this gives a total of three formats, which are listed below.

Format	Contents	Will play on
DVD-Audio	Audio disc with optional text, menus & still pictures but no video	Audio player and Universal player
DVD-AudioV	As DVD-Audio plus video from the DVD-Video specification	Universal player and DVD-Video player (video part only)
DVD-Video	Video but no DVD-Audio audio content	DVD-Video and Universal player

The DVD-Audio data comprises audio objects and management information contained in the directory AUDIO_TS. The additional video data on a DVD-AudioV disc comprises video objects (which comply with a subset of the DVD-Video specification) contained in the directory VIDEO_TS. Due to bandwidth limitations, it is not possible to store high quality audio and video as part of the same AV sequence on a DVD disc.

5.2.2 Copyright Protection

IBM, Intel MEI, and Toshiba have announced the development of a content protection framework for DVD-Audio, endorsed by the five major international record companies. It uses watermark and encryption technologies so that the protected disc will only play on licensed players. The framework also contains a set of options, which provide content owners with the flexibility needed by consumers as the market develops. The system lets consumers make one CD quality copy for personal use and content owners can allow consumers to make additional copies at various levels of quality up to DVD-Audio.

5.3 Audio Coding

The DVD-Audio specification makes use of a scalable linear PCM multi-channel and stereo encoding format, down-mixing control and optional audio formats. The video objects use the same audio encoding as DVD-Video discs.

	Audio Object	Video Object
Coding mode	LPCM or Packed (lossless) PCM	LPCM or Dolby Digital
Sampling frequency (kHz)	44.1/48/88.2/96/ 176.4/192	48/96
Bits per sample	16/20/24	16/20/24
Max channels	6 (up to 96 kHz) or 2 (176.4/192 kHz)	8
Max bit rate (Mb/s)	9.6 (for LPCM)	6.144

The maximum data rate for the audio data is 9.6Mb/s, which means that the sampling frequency for multi-channel audio is limited to 96kHz or less. To make best use of the bandwidth available, multi-channel DVD-Audio can be encoded as two channel groups with different parameters for each group. For example, L, R and C (Left, Right and Centre channels) can be encoded at 96kHz, 24 bits and Ls, Rs (Left and Right surround) at 48kHz, 16 bits. The channel groups can be used in a number of ways and for any number of channels from three (L, R and C) upwards. Mono and stereo only require one channel group.

Down-mix of multi-channel audio to stereo is facilitated by the inclusion of down-mix coefficients, to obtain best results. This technique is called Smart Content (System Managed Audio Resource Technique).

It is possible to store both a 2-channel and 6-channel mix on one disc, for example one on each layer/side of the disc.
In addition to PCM audio, other optional audio formats are possible including:

- Dolby Digital (AC-3), which is the audio encoding format to accompany the video on a DVD-Audio disc.
- MPEG-1 stereo or MPEG-2 multi-channel audio
- Others such as DTS, SDDS etc

5.3.1 Meridian Lossless Packing

To increase the playing time of a DVD-Audio to at least 74 minutes per layer for the highest quality, WG4 has chosen Meridian Lossless Packing (MLP). MLP is easy to implement and will not alter the decoded signal in any way. Decoding MLP requires relatively little computing power even for six channels of 24-bit/96kHz audio.
Another advantage that MLP offers is the availability of a second substream containing the stereo downmix as an alternative to using downmix coefficients that supports players that are not able to decode all 5 or 6 channels.

5.3.2 Playing Times

Examples of playing times are shown below with and without MLP.

Audio combination	Configuration	Single layer	Dual layer	Single layer	Dual layer
				(with MLP)	
2 channels	48kHz, 24bits, 2ch	258 min	469 min	344 min	622 min
2 channels	192kHz, 24bits, 2ch	64 min	117 min	86 min	155 min
6 channels	96kHz, 24bits, 6ch	43 min	78 min	74 min	133 min
5 channels (2 groups)	96kHz, 24 bits, 3ch + 48kHz, 24 bits, 2ch	64 min	116 min	111 min	201 min

The last example uses two channel groups with a lower sampling frequency for the surround channels resulting in additional playing time.

5.4 Additional Content

Additional content can include still pictures, text information, menus & navigation and (for DVD-AudioV discs) video sequences.

5.4.1 Still Pictures

Still pictures are recorded on disc with their associated audio data. Each still is an MPEG-2 Intra-frame and can, optionally, be accompanied by a subpicture for a menu.

Transitions for still images include cut, fade, dissolve and wipe. Two modes are possible:

1. Slide-show mode where the still pictures are displayed as they are loaded from disc while the audio is playing.
2. Browsable mode where up to 19 still pictures are pre-loaded into buffer memory before the audio starts and can be displayed under user or program control.

5.4.2 Text Information

Text is used for the contents, artists' names, Internet URLs, lyrics etc. Static text information can be used for the overall content while dynamic text is suitable for lyrics that change during the audio presentation.

5.4.3 Video content

Video clips follow the DVD-Video specification but certain functions (including multi-story, parental management, region control, user operation control) are not supported. The audio part of the video may be presented without the video.

5.5 DVD-Audio Players

DVD-Audio discs will require new hardware to play them. Various players will become available towards the end of 1999.

- **DVD-Audio players**, which are designed to play audio only with simple text displays and, optionally, a video output to display slide shows and menus.
- **Universal players**, which will play DVD-Audio, DVD-AudioV and DVD-Video discs. It is likely that future DVD-Video players will be universal players. This is because the addition of DVD-Audio capability will not appreciably add to the complexity and cost of the hardware.
- **PCs** and **Macs** with DVD-ROM drives that can readily be upgraded to play DVD-Audio discs.

All players will also play CD audio discs. It is likely that players designed to play SACD discs will also play DVD-Audio discs.

5.6 Super Audio CD

Philips and Sony have been working on an alternative specification called Super Audio CD which uses a different audio coding method, Direct Stream Digital (DSD) and the use of a hybrid disc format.

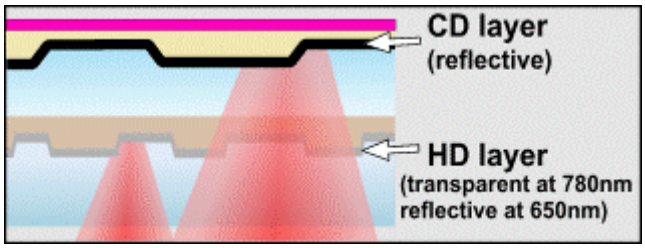
SACD is claimed to fully meet the ISC requirements and to provide a format, which is good for another 20 years. SACD offers high quality, multi-channel audio, CD compatibility, copy protection and added features. The main parameters are:

- Up to 100kHz bandwidth
- 120 dB dynamic range
- Full quality for all channels
- Hybrid disc (CD and DVD)
- Watermarking and copy protection
- Text, graphics and video

DSD was chosen as the encoding format because it avoids using PCM, which is an unnecessary, intermediate format and DSD is the best format for archiving. DSD is claimed to offer high quality audio with lossless compression and to be more future proof than PCM. Parameters include 100kHz frequency response and 120dB dynamic range on all channels. Philips and Sony recommend that recording studios use DSD and convert to CD audio using a process called Super Bit Mapping Direct.

Watermarking for copy protection uses pit signal processing (PSP) which cannot be copied by any known piracy process. There is also a visible watermark.

The hybrid CD/DVD disc format allows the same disc to play on existing audio players as well as Super Audio CD players. This is possible by moulding the CD-Audio pits on the outside of the otherwise blank DVD substrate (see Figure 1) and using a semi-reflective layer for the DVD metallisation, thus allowing the CD-Audio layer to be read by a conventional CD player.



The result would guarantee that DVD audio discs would be playable on existing CD players, easing consumer fears of obsolescence. However 'hybrid' discs are more difficult and therefore more expensive to manufacture than CDs. It is for this reason that few if any hybrid discs may become available when DVD-Audio and SACD discs and players are launched.

The SACD specification is contained in the Scarlet Book. SACD discs are DVD discs in that they use the same sector size, error correction and modulation as DVD discs and the same file system (UDF plus ISO 9660).

6 DVD-R and RAM

6.1 DVD-R/DVD-RAM Introduction

The DVD family would be incomplete without recordable versions. CD-Recordable discs were introduced in 1988 and CD-RW (the re-writable version) has only recently been introduced some 15 years after the first read-only CD was launched.

Both recordable (DVD-R) and re-writable (DVD-RAM) DVD discs have been developed. Recorders and discs for DVD-R have been available since 1997 but at a high price and DVD-RAM recorders and discs are available but at a much lower price. This time round the timescales are being compressed partly due to the technology being available and partly because there is already a need for such discs for development purposes and for small volume production.

Both DVD-R and DVD-RAM currently offer a lower capacity than read-only DVD discs. This limits their usefulness to applications where the full capacity of read-only DVD is not required. However, this capacity will increase to a full 4.7GB per side by the middle of 1999 for both DVD-R and DVD-RAM.

Alternative formats to DVD-RAM have been proposed and one of these, DVD-RW, is now being considered by the DVD Forum. Other formats, including DVD+RW, are being developed and products are planned to be launched by 2000.

6.2 DVD-Recordable (DVD-R)

DVD-R discs make use of a similar technology to CD-Rs but with a different dye and smaller geometries. There are two versions with different storage capacity.

Parameter	Ver 1.0	Ver 1.9/2.0
Sides	1 or 2	1 or 2
Capacity (GB)	3.95 per side	4.7 per side
Availability	since 1997	mid 1999
Recording method	Organic dye layer, 635nm laser	
Min pit length (microns)	0.44	0.40
Track pitch (microns)	0.80	0.74
Track format	Wobble pre-groove	
Modulation and error correction	8 to 16 & RSPC	

DVD-R is fully compatible with DVD-ROM, DVD-Video and DVD-Audio so that recorded DVD-R discs can be read on any suitable DVD hardware, depending on the format of the data contained on the DVD-R.
DVD-R discs will comprise the following data areas:

- Power Calibration Area (PCA
- Recording Management Area (RMA)
- Lead-in Area
- Data Recordable Area
- Lead-out Area

DVD-R discs allow incremental writing (cf CD-R multisession writing). Two types of incremental writing are defined:

1. Type 1 allows DVD-R discs to be read by an ISO 9660 system, and uses the UDF Bridge file system.
2. Type 2 is for drag and drop file transfer and uses UDF without ISO 9660.

For both types each section of data written to the disc is a Bordered Area and is followed by the Border Out and Border In which precedes the next Bordered Area (if any). Each Bordered Area begins with the UDF file system and ends with the Virtual Allocation Table (VAT).

DVD-R discs and recorders are available, but at a high price. Current DVD-R discs have a capcity of only 3.95 GB. 4.7GB recorders and discs will be available in 1999.
The DVD Forum working group WG6 is responsible for developing the DVD-R format and plan to publish the DVD-R Book ver 2.0 in the spring of 1999.

6.3 DVD Re-writable (DVD-RAM)

DVD-RAM discs use phase change recording where the active layer is made to change between amorphous and crystalline state by means of a laser at different power. DVD-RAM discs use Zoned CLV (ZCLV) method instead of CLV, where the angular velocity continuously changes. Within each zone the data is written/read using the CAV method, the angular velocity changing from zone to zone to maintain a constant average linear velocity. The data is written on both land and groove, the address information being moulded into the disc as pits.

Parameter	Ver 1.0	Ver 1.9/2.0
Sides	1 or 2	1 or 2
Capacity (GB)	2.6 per side	4.7 per side
Availability	Now	1999
Recording method	Phase change marks	
Track format	Wobbled Land & Groove	
Track pitch (microns)	0.74	0.615
Min pit length (microns)	0.41	0.28
Number of zones	24	35
User data rate (Mb/s)	11.08	22.16
Caddy	Yes	
Modulation and error correction	8 to 16 & RSPC	

The ver 1.9 specification was released in November 1998 and the ver 2.0 specification is due in the spring of 1999. WG5 is responsible for the development of the DVD-RAM format.

6.4 Other Re-writable Formats

Alternative re-writable formats are being developed.
DVD+RW, developed and proposed by Hewlett-Packard, Philips, and Sony with the

support of Verbatim, Ricoh and Yamaha. Philips and Sony are also members of the DVD Forum but believe that DVD+RW is more compatible with existing DVD-ROM drives than DVD-RAM. DVD+RW discs have a capacity of 3GB and do not need a cartridge.
Features of DVD+RW are claimed to be:

- Compatible with DVD-ROM drives
- No need for cartridge
- 4.7GB capacity under development
- Choice of CAV for high performance data storage applications and CLV for video recording
- Backed by industry leaders in CD-RW.

DVD-RW is Pioneer's format which is an evolutionary development based on existing CD-RW technology and with a capacity of 4.7GB. Its phase-change technology means that discs have a higher reflectivity than DVD-RAM or DVD+RW media, and can be read in existing DVD-ROM drives. This format has been accepted by the DVD Forum for evaluation as a possible member of the DVD family. Discs and players are due to be available soon.
MMVF (Multimedia Video File) format from NEC offers a 5.2GB capacity on one side and is more suitable than the other formats for a video recording format.

6.5 DVD-Video Recording

Neither DVD-R nor DVD-RAM have the capacity for a digital replacement for the VHS recorder. DVD-Video recorders will need low cost MPEG-2 encoding and a re-writable disc capable of storing at least 10GB.
However, Philips and other manufacturers have announced digital video recorders based on existing DVD recordable formats including DVD-RAM and DVD+RW. Low cost, real-time MPEG-2 encoders are now available, but it will still take two years or more before there is a DVD based product that will compete with the VHS for playing time and cost.
Manufacturers are looking at new technologies, such as the SHG (second harmonic generation) blue laser to achieve capacities of 15GB or more. Such capacities will be needed to realise the playing time and quality that will be needed.
One significant issue with digital recording is that it will be possible to create a perfect, or near-perfect, copy of the original. Therefore the issue of copyright protection becomes even more important and will need to be addressed in parallel with the

development of the technology.

7 DVD MANUFACTURING

7.1 Introduction

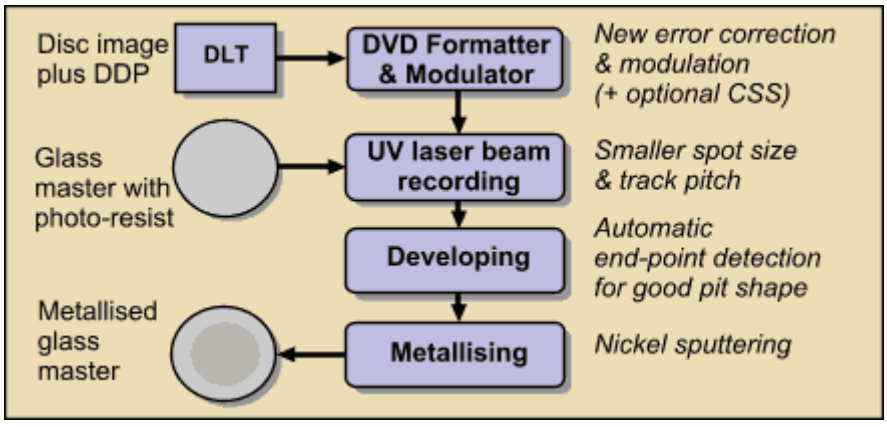
DVD discs are more difficult to manufacture than CDs, requiring new, purpose designed equipment rather than upgraded equipment. DVD discs are different from CDs in the following ways:

- Pit sizes half that of CD pits
- Track pitch half that for CDs, with tighter tolerances
- Higher mastering speeds, both in angular and linear velocity and data rate
- New data formatting requirements, particularly for dual layer discs.
- Two disc substrates to mould per final disc, each half the thickness of a CD
- Tighter tolerances on tilt and jitter in particular
- Additional bonding stage, which for dual layer discs must be optically transparent and of the correct thickness.
- A range of disc formats including dual layer and double sided discs.

These differences require new or modified mastering equipment, moulding machines, metallisers and inspection equipment plus a new bonding stage, which present new challenges for equipment manufacturers and replicators.

7.2 DVD Glass Mastering

The differences between DVD and CD means that much of the mastering process for DVD needs new equipment including improved glass master preparation, laser beam recording and developing.



- The photo-resist layer should, ideally be about 120 nm in thickness (instead of 140 nm for CD) but successful mastering using the same thickness as for CDs is possible. Any defects or variations in thickness of this layer must be kept very small.
- Laser beam recording requires a smaller spot size, higher numerical aperture and tighter tolerances than for CDs. Many LBRs designed for DVD mastering use a UV laser (instead of the blue or violet laser used for CDs). To handle CD and DVD mastering, it is necessary to change the numerical aperture from 0.6 for CD to 0.9 for DVD mastering.
- DVD data is formatted differently from CDs and requires new formatting hardware/software to handle the RSPC error correction, 8 to 16 modulation and the higher channel data rate.
- Stamper finishing requires more care than for CDs, since tilt (variations in flatness of the final disc) is critical for DVD.
- DVD-9 (dual layer) discs require the upper layer (layer 1) to be mastered with the turntable rotating in the reverse direction. Also, the direction of writing will be either from the inside to outside (parallel track) or outside to inside (opposite track), depending on the application requirements.
- CSS (Content Scrambling System) copy protection is carried out at the mastering stage. The data on DLT is combined with the encrypted keys and the audio and video data scrambled using these keys, which are hidden on the DVD disc.

7.3 DVD Replication

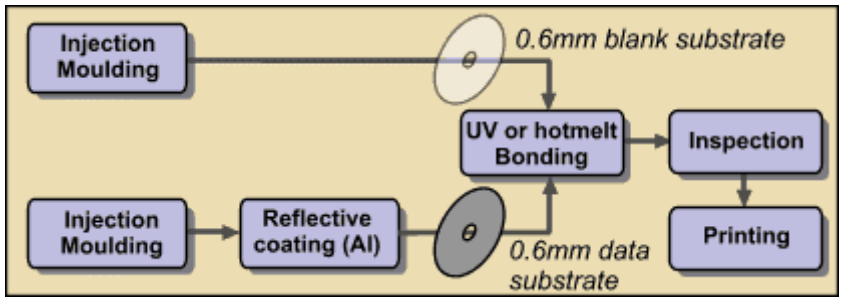
All DVD discs comprise two substrates each 0.6mm thick and moulded separately. The replication process varies somewhat for the different formats. DVD-5 and DVD-10 were the first to be manufactured. DVD-9 has proved to be considerably more difficult due to the different metallisation and bonding requirements.
DVD moulding is similar to CD moulding but with some important differences.

- Two pressings are needed for each final DVD disc
- Each half disc (substrate) is 0.6mm thick instead of 1.2mm
- The thinner disc also requires different moulding parameters, such as a shorter injection time and higher mould temperature.
- Redesigned or new moulding machines are needed with injection compression where the mould is kept slightly apart until most of the polycarbonate has been

injected.

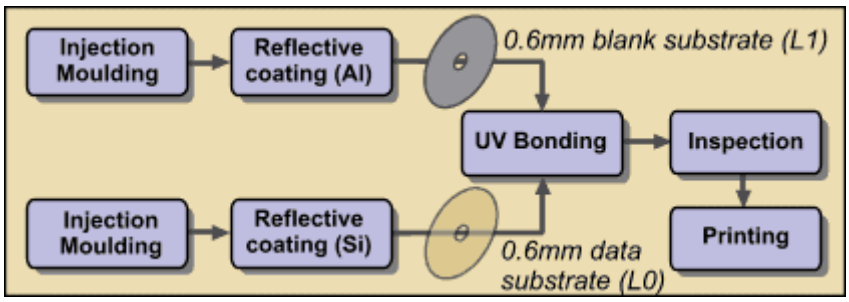
The quality of the final disc, including tilt and jitter, is critically dependent on the moulding process.

For DVD-5 discs, the active substrate is metalised and then bonded with the blank, non-metalised substrate.



For DVD-10, both substrates are metalised.

For DVD-9 discs two metalisation layers are required, one being semi-reflective, using gold or silicon. Parameters such as tilt, bonding layer transparency etc are more severe for DVD-9. Also the layer 1 aluminium layer must be uniform in thickness to avoid jitter.



7.4 DVD Bonding

Bonding is one of the most difficult parts of the process. There are a number of possible solutions.

- Hot melt bonding is the method used for Laserdiscs where the two substrates just need to be glued together. It is also suitable for single layer (single or double sided) DVDs. The process is simple and relatively inexpensive, but tends now to be replaced by UV bonding.
- Radical UV Cured bonding is suitable for dual layer discs because it is

transparent. It involves coating one or both of the substrates with a UV cured resin similar to normal lacquer, but with suitable optical and mechanical characteristics.

- Cationic UV Bonding involves screen printing the resin over both substrates, curing each with UV light and then pushing the discs together. This method is not suitable for dual layer discs as the resin used is opaque.

DVD-9 bonding is particularly difficult as the bonding layer must

- be of uniform thickness within close tolerances
- be optically transparent with no defects such as bubbles
- not introduce tilt outside the DVD specification

7.5 DVD Disc Finishing

Finishing comprises label printing, for which there are a number of options, and adding the Burst Cutting Area.

Printing options	DVD-5	DVD-9	DVD-10
Normal printing on upper surface of disc (like CDs)	Yes	Yes	No
Printing on inside surface of blank substrate to give smooth 'glossy' effect	Yes	No	No
Pit Art where a holograph like image is moulded into the blank substrate	Yes	No	No
Printing on both sides but only within hub area	-	-	Yes

In the diagram below, the printable areas for DVD-5, DVD-10 and DVD-9 discs are shown in blue.

Burst Cutting Area (BCA) is an annular area within the disc hub where a bar code can be written for additional information such as serial numbers.

7.6 DVD Quality Assurance

DVD inspection and testing requires the use of some different techniques, new parameters to be tested and new readers.

- DVD glass mastering must be checked using a DVD stamper player to check the stamper prior to replication.
- DVD inspection is similar to CD inspection but includes tilt. Discs must be inspected after bonding as this stage can introduce tilt and other defects. DVD-10 and DVD-9 discs need inspection of both top and bottom of each disc. DVD-9 need inspection of the semi-reflective layer and the bonding gap.
- DVD bit verification needs new equipment to read the data.
- DVD measurements need new equipment plus new and modified tests.

2. Reference Information

2-1 Component Descriptions

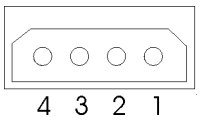
2-1-1 DVD ATAPI Loader

D.C. Power Supply

A 4-pin shrouded, keyed male connector is used to provide the D.C.Power.

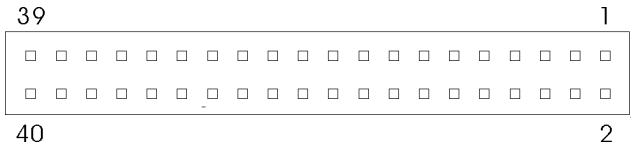
The pin assignment is described below.

PIN	DC VOLTS
1	+12V
2	GND
3	GND
4	+5V



Interface Connector

A 39-pin male, unshielded, shrouded, keyed connector are applied.
Please refer to Section 7-2-3 regarding its pin definition.



Electrical Characteristics

1. Power

1-1. Voltage

+5V DC with ± 5% tolerance. Less than 100mVp-p Ripple Voltage
+12V DC with ± 10% tolerance, less than 150mVp-p Ripple Voltage

1-2. Current

Continuous Reading

+5V DC	500mA (Average)
+12V DC	300mA (Average)

Seeking & Spin up

+5V DC	0.8A (Maximum)
+12V DC	1.5A (Maximum)

2. Signal Summary

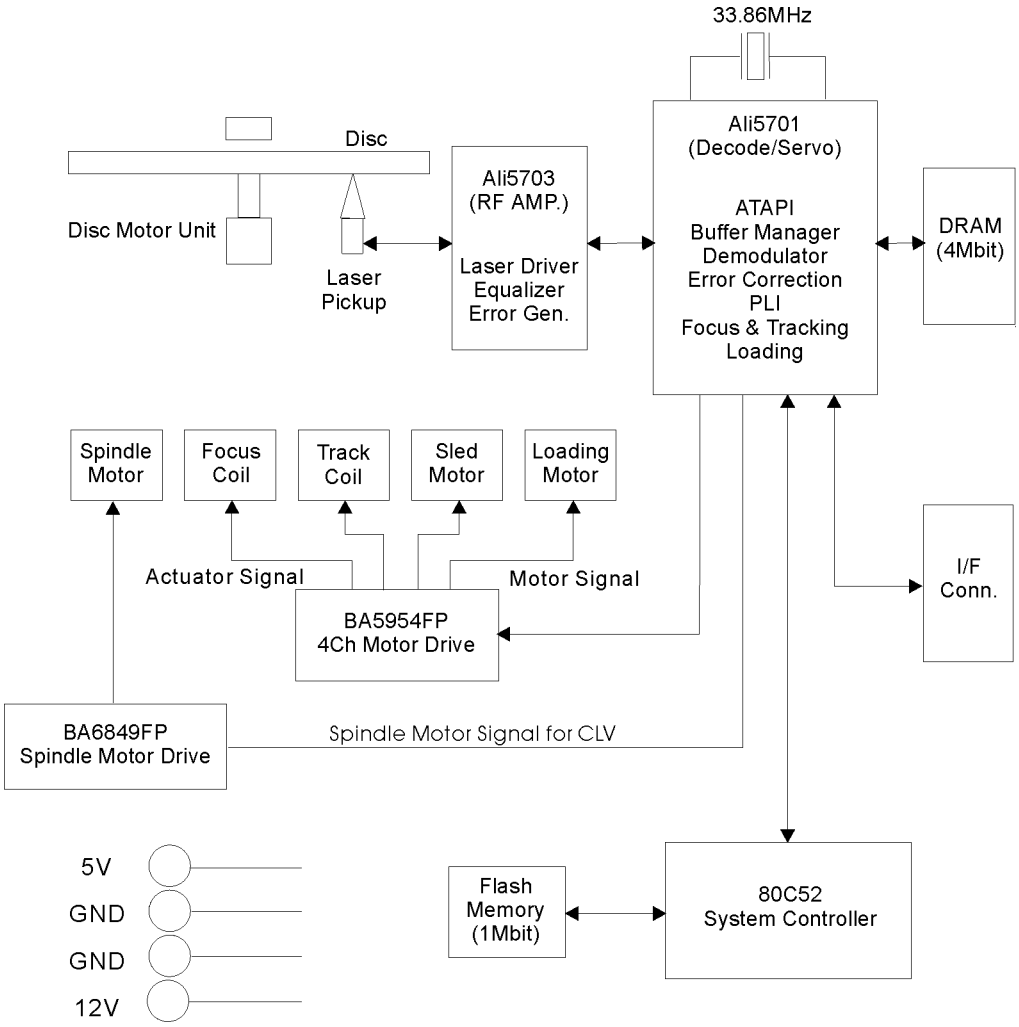
The physical interface consists of single ended TTL compatible receivers.

3. Connector Pin Definition

I/F Signals	I/O Pin #	I/F Signals	I/O Pin #
Reset	1	DMARQ	21
GND	2	GND	22
DD7	3	DIOW	23
DD8	4	GND	24
DD6	5	DIOR	25
DD9	6	GND	26
DD5	7	IORDY	27
DD10	8	CSEL	28
DD4	9	DMACK	29
DD11	10	GND	30
DD3	11	INTRQ	31

I/F Signals	I/O Pin #	I/F Signals	I/O Pin #
DD12	12	IOCS16	32
DD2	13	DA1	33
DD13	14	PDIAG	34
DD1	15	DA0	35
DD14	16	DA1	36
DD0	17	CS1FS	37
DD15	18	CS3FS	38
GND	19	DASP	39
NC	20	GND	40

4. Block Diagram



2-1-2 NTSC/PAL Digital Video Encoder (AV3168)

FEATURES

- Fully CCIR 624 performance compliance NTSC and PAL (B,D,G,H,I,M and N) video encoder.
- Composite, S-video, Component Y/Cb/Cr (Sony, Matsushita, and SMPTE) or RGB output.
- Triple 10-bit digital to analog converter.
- Accepts 27 Mhz multiplexed 8-bit digital video inputs.
- Master or Slave 4-Field NTSC or 8-Field PAL video timing generation.
- CCIR 656 EAV SYNC extraction.
- Automatic NTSC or PAL timing detection in slave mode operation.
- Automatic or User Programmable Chroma Filter Selection.
- Macrovision Anti-Tapping Rev 7.01 support in AV3168 Only.
- Closed Caption Support.
- Contrast and Brightness control.

Clock Generation

- 3 outputs for 27 MHz video clock, 16.934, 18.432 and 36.864 Mhz audio clock, and 40.5, 54.0, 67.5 and 81.0 MHz general purpose clocks.
- Requires a single 27 Mhz crystal.

General

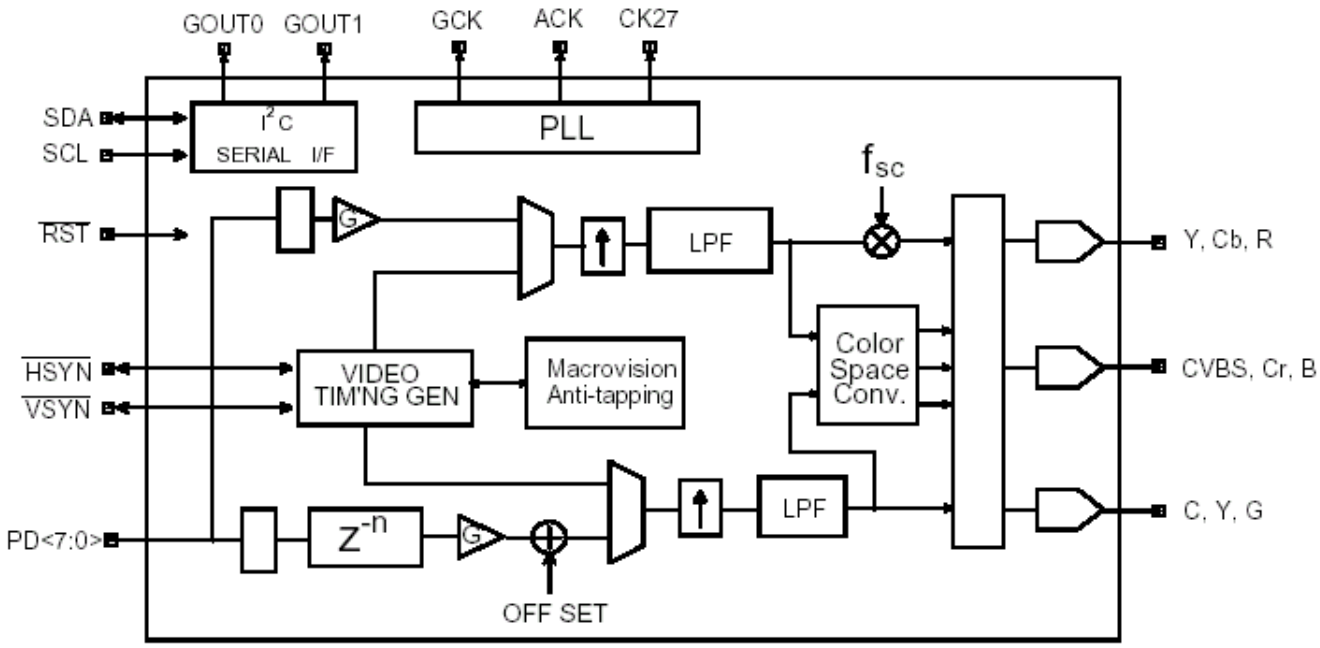
- CVBS and S-video DAC power down controls.
- I^2C compatible serial control bus.
- Single +5 volt power supply.

Application

- Digital Video Disk (DVD)
- Digital Set-Top Box
- PC Video, Multimedia

Ordering Information

AV3168/69-CL 44-pin PLCC
AV3168/69-CQ 44-pin TQFP

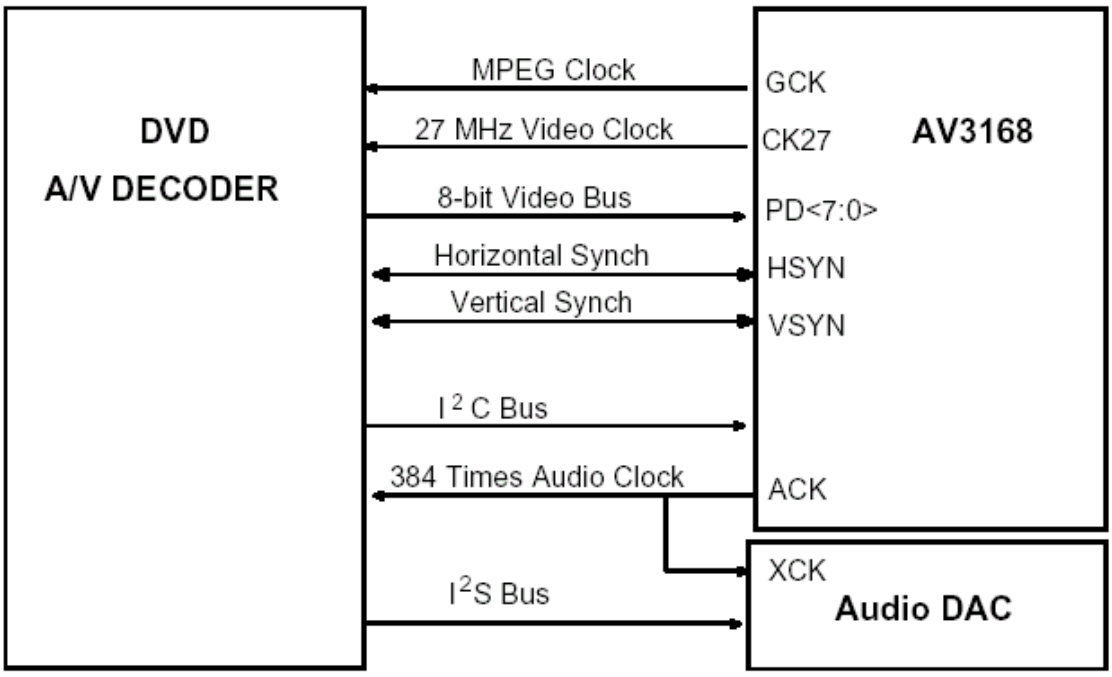


DESCRIPTION

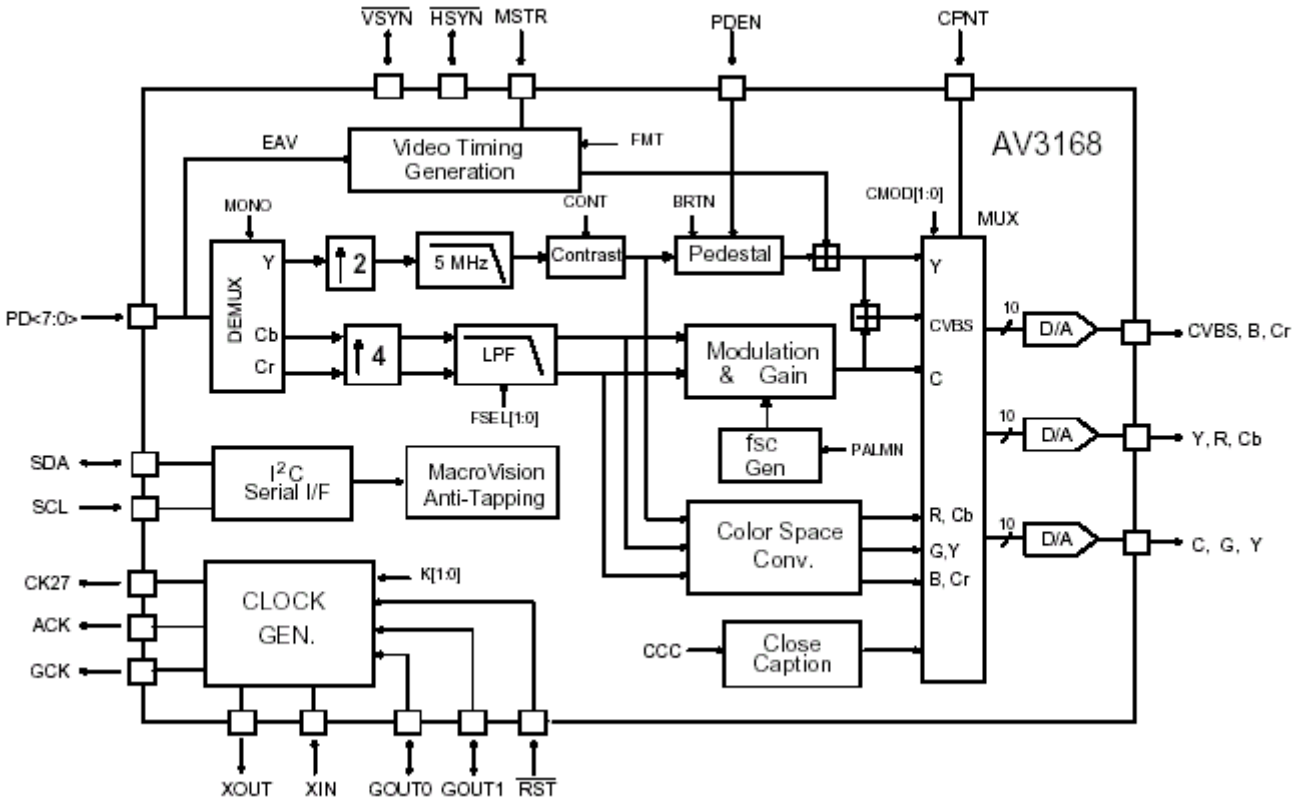
The AV3168 is a mixed signal CMOS monolithic device. It comprise with a PAL and NTSC Video Encoder, Color Space Converter and Clock Generator, The Clock Generator outputs a video, an audio and a programmable general purpose clock. This IC implemented Macrovision Anti-tapping 7.01, intended for DVD and Settop Box applications.

The video encoder converts CCIR 601 8-bit multiplexed digital video into RGB, component YCbCr, encoded NTSC or PAL (BDGHIMN) signals. It contains three 10-bit DACs to support simultaneous S-video and composite video; or component video display. Brightness and Contrast control are also provided.

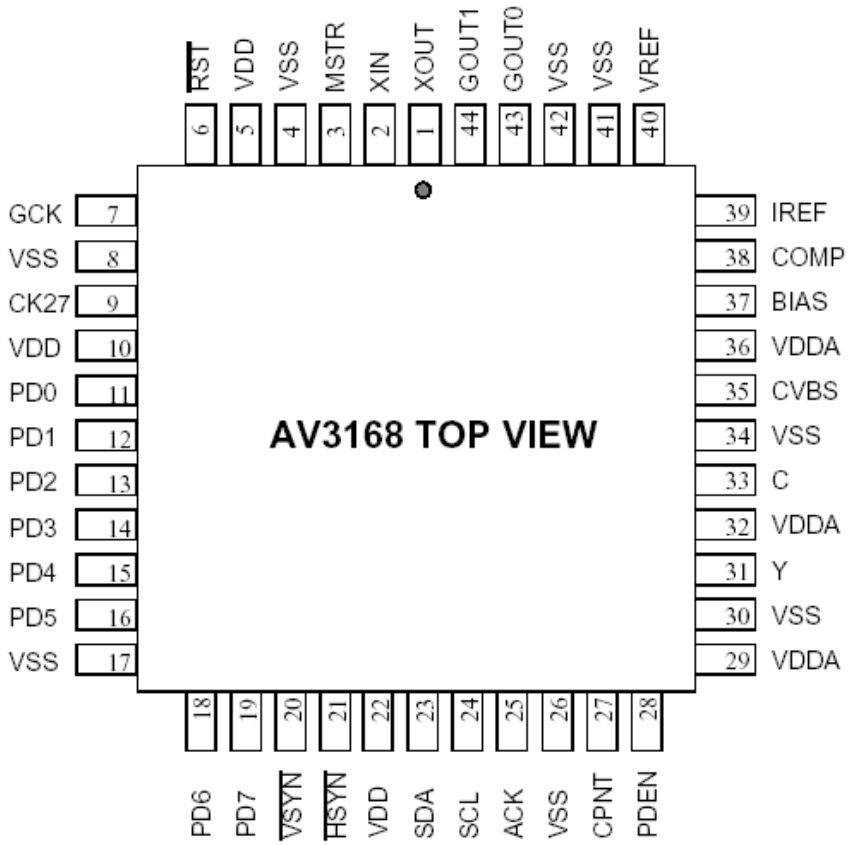
The Clock Generator outputs three clocks for video, audio and system to simplify the system configuration and maintain A/V synchronization.



Typical Application Connection



AV3168 Detailed Block Diagram



PIN DESCRIPTIONS

Pin Name	Pin #	Type	Description
DIGITAL VIDEO INPUT			
PD<7 -0>	11-16 18-19	I	Multiplexed Cb, Y, and Cr digital video input bus.
$\overline{\text{HSYN}}$	20	I/O	In Slave Mode (MSTR pin is low) Horizontal Synch input. In Master Mode (MSTR pin is high) Horizontal Synch output.
$\overline{\text{VSYN}}$	21	I/O	In slave mode (MSTR pin is low) Vertical Sync input. In master mode Vertical Sync output.
VIDEO CONTROL SIGNALS			
MSTR	3	I	Master Mode; If this pin is high, the chip outputs horizontal and vertical sync signals. Otherwise it receives both horizontal and vertical sync signals.
CPNT	27	I	Select either component or composite video output. 0: Simultaneous Composite and S-Video output. 1: Component video output either RGB or YCbCr determined by the register CR0[5:4].
PDEN	28	1	Pedestal enable pins. When this pin is high 7.5 IRE is added for the NTSC composite analog output.
VIDEO ANALOG OUTPUT, REFERENCE AND COMPENSATION			
CVBS	35	O	Analog video output Determined by the state of CPNT pin and CR0[5:4] CPNT CR0[5] CR0 [4] 0 X X: Composite video output

Pin Name	Pin #	Type	Description
			1 X 0: Cr output in CbCr component mode 1 0 X: : 1 1 1: Blue color output in RGB mode
Y	31	O	Analog video output Determined by the state of CPNT pin and CR0[5:4] CPNT CR0[5] CR0 [4] 0 X X: S-Video Y output. 1 X 0: Cb output in CbCr component mode 1 0 X: : 1 1 1: R color output in RGB mode
C	33	O	Analog video output Determined by the state of CPNT pin and CR0[5:4] CPNT CR0[5] CR0 [4] 0 X X: S-Video C output. 1 1 0: Cb output in CbCr component mode 1 0 X: : 1 1 X: Green color output in RGB mode
VREF	40	I/O	Voltage reference. It has an internal voltage reference circuit, but may be overridden by an external voltage reference input. A 0.1 uF ceramic capacitor is required between this pin and GND.
IREF	39	I	A resistor should be connected between this pin and GND to control the DAC output current. The recommended value is 198 (382) ohm 1% metal film resistor for double (single) end 75 ohm termination.
COMP	38	I	Compensation capacitor for the DAC internal reference amplifier. A 0.1 uF ceramic capacitor is required between this pin and VDDA.
BIAS	37	I/O	DAC bias voltage. A 0.1 uf ceramic capacitor must be used to de-couple this pin to VDDA.
SERIALCONTRL BUS			
SCL	24	I	Serial bus clock
SDA	23	I/0	Serial bus address and data input and output pin. Open drain output.
CLOCK SIGNALS			
GCK	7	O	General Purpose Clock. Clock frequency is determined by the state of GOUT[1:0] when $\overline{\text{RST}}$ pin is low. 0 0 : 40.5 MHz clock output. 0 1: 54.0 MHz clock output. 1 0: 67.5 Mhz clock output. 1 1: 81.0 MHz
GCK	7	O	General Purpose Clock. Clock frequency is determined by the state of GOUT[1:0] when $\overline{\text{RST}}$ pin is low. 0 0 : 40.5 MHz clock output. 0 1: 54.0 MHz clock output. 1 0: 67.5 Mhz clock output. 1 1: 81.0 MHz
CK27	9	O	27 MHz clock output pin.
ACK	25	I/O	384*fs Audio clock output pin. Controlled by CR2[1:0] 0 0: 384 * 44.1 KHz (16.934MHz) clock output. 0 1: 384 * 48.0 KHz (18.432MHz) clock output. 1 0: 384 * 88.2 KHz (33.868MHz) clock output. 1 1. 384 * 96.0 KHz (36.864MHz) clock output.
XIN	2	I	27 Mhz oscillator input
XOUT	1	O	27 Mhz oscillator output
MISCELLANEOUS SIGNALS			
$\overline{\text{RST}}$	6	I	Active low chip reset input. Chip is in the power down mode when the $\overline{\text{RST}}$ is low.
GOUT1	44	O	Dual function pin.

Pin Name	Pin #	Type	Description
			GCK frequency select pin when $\overline{RST}$ is low. General purpose output pin when $\overline{RST}$ is high
GOUT0	43	I	Dual function pin. GCK frequency select pin when $\overline{RST}$ is low. General purpose output pin when $\overline{RST}$ is high
POWER AND GROUND			
VDD	10, 22, 5	+5V	Digital power supply
VSS	8, 17, 26, 30, 34, 41, 42, 4	GND	Digital ground
VDDA	29, 32,36	+5V	Analog video power supply

2-1-3 DVD Processor Chip (Swan-2™ ES4318)

* Features

- Single-chip DVD video decoder in a 208-pin PQFP package
- Supports MPEG-1 system and MPEG-2 program streams
- Programmable multimedia processor architecture
- Compatible with Audio CD, Video CD, VCD 3.0, and Super Video CD (SVCD)
- DVD Navigation 1
- Built-in content Scrambling System (CSS)

- Audio

- Built-in Karaoke key-shift function
- DolbyTM Digital 2-channel down mix audio output for DolbyTM
- Dolby Pro Logic
- Linear PCM streams for24 bit / 96KHz
- Concurrent S/PDIF out and 2-channel audio output
- Sensaura Dolby Digital Virtual Surround
- DTS Digital Surround 2-channel down mix stereo output
- S/PDIF output for encoded AC-3, DTS Digital output or Linear PCM

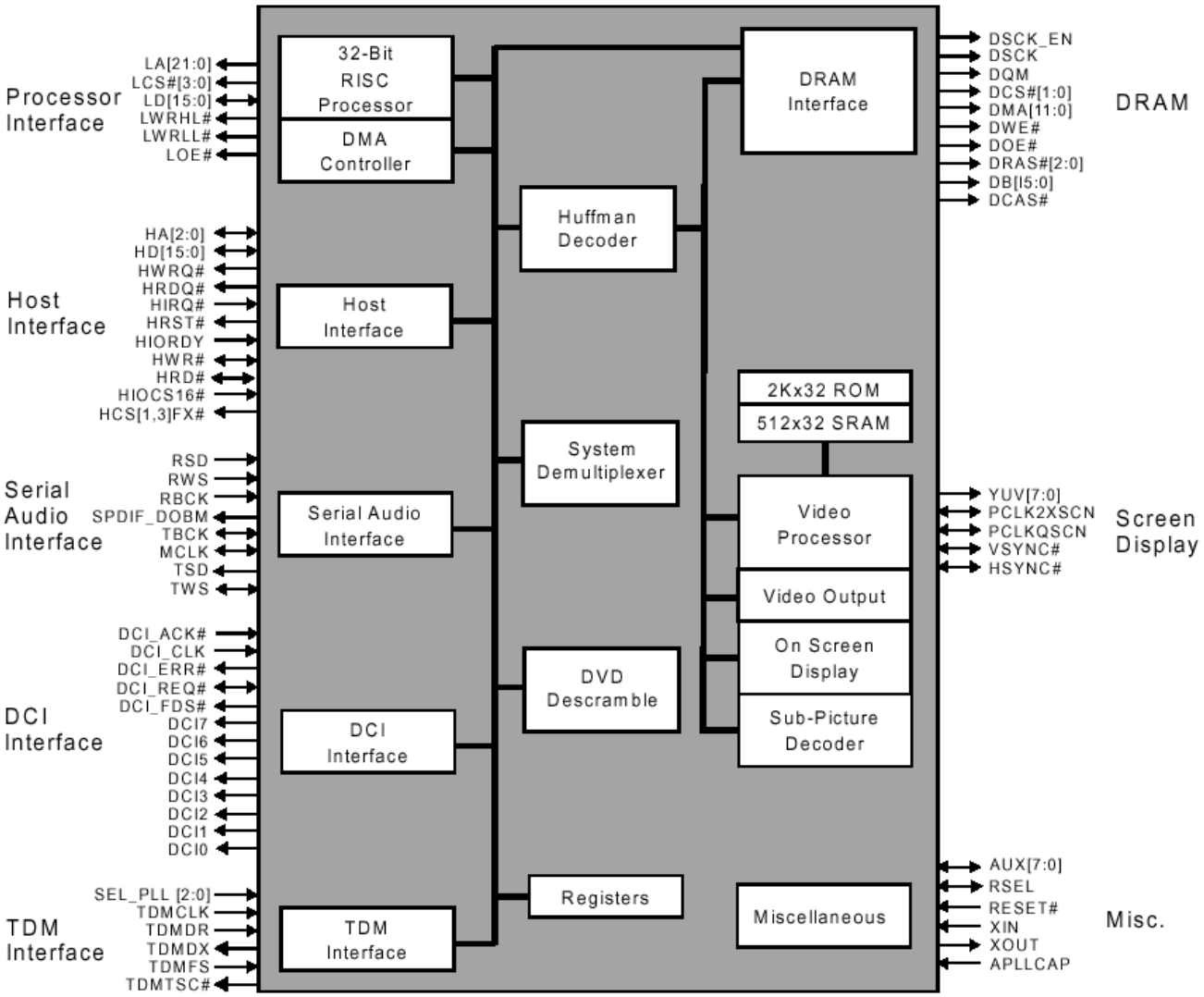
- Peripheral

- Glueless interface to DVD loaders (ATAPI or A/V bus I/F)
- Bi-directional 12C audio interface
- 8 general-purpose auxiliary ports
- Single 27MHz clock input

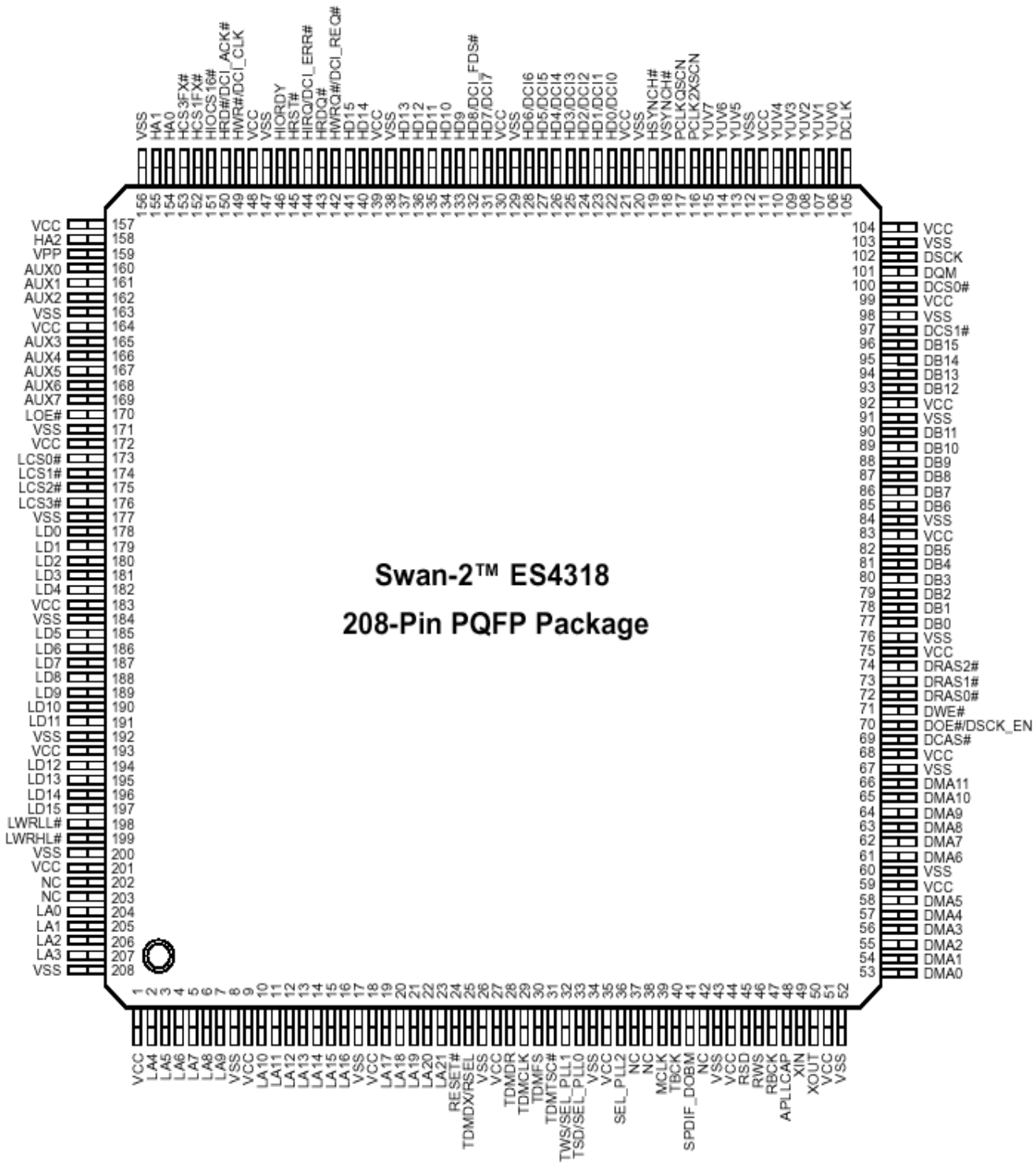
- Smart Technology

- SmartZoomTM for motion zoom & pan
- SmartZoomTM for NTSC to PAL conversion and vice versa
- SmartZoomTM for video error concealment

* Functional Description



* Pinout Diagram



* PIN DESCRIPTON

Name	Number	I/O	Definition
VCC	1, 9, 18, 27, 35, 44, 51, 59, 68, 75, 83, 92, 99, 104, 111, 121, 130, 139, 148, 157, 164, 172, 183, 193, 201	I	3.65 V ± 150 mv.
LA[21:0]	23:19, 16:10, 7:2, 207:204	O	Device address output
VSS	8, 17, 26, 34, 43, 52, 60, 67, 76, 84, 91, 98, 103, 112, 120, 129, 138, 147,156,163,171,177,184, 192, 200, 208	I	Ground
RESET#	24	I	Reset input active low.
TDMDX		O	TDM transmit data
RSEL	25	I	ROM Select RSEL Selection 0 16-bit ROM 1 8-bit ROM
TDMDR	28	I	TDM receive data.
TDMCLK	29	I	TDM clock input.
TDMFS	30	I	TDM frame synch.
TDMTSC#	31	O	TDM output enable, active low.
TWS SEL_PLL1	32	O I	Audio transmit frame sync. Select PLL1.
TSD SEL_PLL0	33	O I	Audio transmit serial data port. Select PLL0. SEL_PLL2 SEL_PLL0 Clock Output 0 0 2.5 x DCLK 0 1 3 x DCLK 1 0 3.5 x DCLK 1 1 4 x DCLK
SEL_PLL2	36		Select PLL2. See the table for pin number 33.
MCLK	39	I/O	Audio master clock for audio DAC.
TBCK	40	I/O	Audio transmit bit clock.
SDIF_DOBM	41	O	S/PDIF (IEC958) Format Output.
RSD	45	I	Audio receive serial data.
RWS	46	I	Audio receive frame synch.
RBCK	47	I	Audio receive bit clock.
APLLCAP	48	I	Analog PLL Capacitor.
XIN	49	I	Crystal input.
XOUT	50	O	Crystal output.
DMA[11:0]	66:61, 58:53	O	DRAM address bus.
DCAS#	69	O	Column address strobe, active low.
DOE# DSCK-EN	70	O I	Output enable, active low. Clock enable, active low.
DWE#	71	O	DRAM write enable, active low.
DRAS[2.0]#	74:72	O	Row address strobe, active low.
DB[15:0]	96:93, 90:85, 82:77	I/O	DRAM data bus.
DCS[1:0]#	97,100	O	SDRAM chip select [1:0], active low.
DQM	101	O	Data input/ output mask.
DSCK	102	O	Clock to SDRAM.
DCLK	105	I	Clock input (27MHz).
YUV[7.0]	115:113, 110:106	O	8-bit YUV output.
PCLK2XSCN	116	I/O	2X pixel clock.
PCLKQSCN	117	I/O	Pixel clock.
VSYNCH#	118	I/O	Vertical synch for screen video interface, programmable for rising or falling edge, active low.
HSYNCH#	119	I/O	Horizontal synch for screen video interface, programmable for rising or falling edge,

Name	Number	I/O	Definition
			active low.
HD[15:0]	141:140, 137:131, 128:122	O	Host data bus
HCS1FX#	152	O	Host select 1.
HCS3FX#	153	O	Host select 3.
HIOCS16#	151	I	Device 16-bit data transfer.
HA[2:0]	158, 155:154	I/O	Host address bus.
VPP	159	I	Peripheral protection voltage.
HWR#/DCI_ ACK#	149	I,I	Host write/DCI interface Acknowledge Signal, active low.
HRD#DCI-C LK	150	I,I	Host read/DCI Interface Clock.
HD[15:0]	141:140, 137:131, 128:122	I/O	Host data bus.
HWRQ#	142	O	Host write request.
HRDQ#	143	O	Host read request.
HIRQ	144	I/O	Host interrupt.
HRST#	145	O	Host reset.
HIORDY	146	I	Host I/O ready.
HWR#	149	O	Host write request.
AUX[7:0]	169:165, 162:160	I/O	Auxiliary ports.
LOE#	170	O	Device output enable, active low.
LCS[3:0]#	176:173	O	Chip select[3.0], active low.
LD[15;0]	197:194, 191:185, 182:178	I/O	Device data bus.
LWRLL#	198	O	Device write enable, active low.
LWRHL#	199	O	Device write enable, active low.
NC	37, 38, 42, 203:202		No Connect pins. Leave open

2-1-4 8-Pin, 24-Bit, 96kHz Stereo D/A CONVERTER (CS4338)

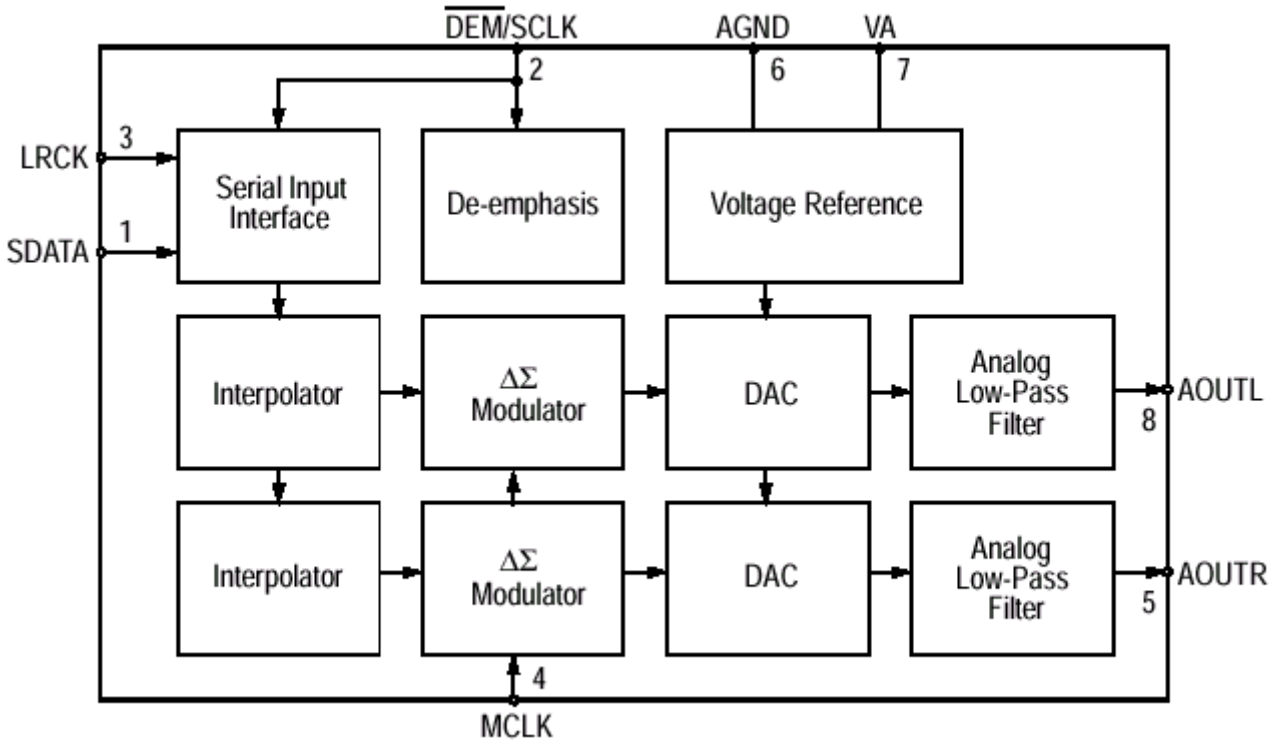
Features

- Complete Stereo DAC System: Interpolation, D/A, Output Analog Filtering
- 24-Bit Conversion
- 96 dB Dynamic Range
- -88 dB THD+N
- Low Clock Jitter Sensitivity
- Single +5 V Power Supply
- Filtered Line Level Outputs
- On-Chip Digital De-emphasis
- Popgaurd® Technology
- Functionally Compatible with CS4330/31/33

Description

The CS4334 family members are complete, stereo digital-to-analog output systems including interpolation, 1-bit D/A conversion and output analog filtering in an 8-pin package. The CS4334/5/6/7/8/9 support all major audio data interface formats, and the individual devices differ only in the supported interface format.

The CS4334 family is based on delta-sigma modulation, where the modulator output controls the reference voltage input to an ultra-linear analog low-pass filter. This architecture allows for infinite adjustment of sample rate between 2 kHz and 100 kHz simply by changing the master clock frequency. The CS4334 family contains on-chip digital de-emphasis, operates from a single +5V power supply, and requires minimal support circuitry. These features are ideal for set-top boxes, DVD players, SVCD players, and A/V receivers.



PIN DESCRIPTIONS

SERIAL DATA INPUT	**SDATA**	1	8	**AOUTL** ANALOG LEFT CHANNEL OUTPUT
DE-EMPHASIS / SCLK	**DEM/SCLK**	2	7	**VA** ANALOG POWER
LEFT / RIGHT CLOCK	**LRCK**	3	6	**AGND** ANALOG GROUND
MASTER CLOCK	**MCLK**	4	5	**AOUTR** ANALOG RIGHT CHANNEL OUTPUT

No.	Pin Name	I/O	Pin Function and Description
1	SDATA	I	***Serial Audio Data Input*** - two's complement MSB-first serial data is input on this pin. The data is clocked into the CS4334/5/6/7/8/9 via internal or external SCLK, and the channel is determined by LRCK.
2	DEM/SCLK	I	***De-Emphasis/External Serial Clock Input*** - used for de-emphasis filter control or external serial clock input.
3	LRCK	I	***Left/Right Clock*** - determines which channel is currently being input on the Audio Serial Data Input pin, SDATA.
4	MCLK	I	***Master Clock*** - frequency must be 256x, 384x, or 512x the input sample rate in BRM and either 128x or 192x the input sample rate in HRM.
5	AOUTR	O	***Analog Right Channel Output*** - typically 3.5 Vp-p for a full-scale input signal.
6	AGND	I	***Analog Ground*** - analog ground reference is 0V.
7	VA	I	***Analog Power*** - analog power supply is nominally +5V.
8	AOUTL	O	***Analog Left Channel Output*** - typically 3.5 Vp-p for a full-scale input signal.

2-1-5 Serial EEPROM, 2K (256 x 8) (AT24C02/01)

*** Features**

- Low-Voltage and Standard-Voltage Operation

  -5.0 (V CC = 4.5V to 5.5V)

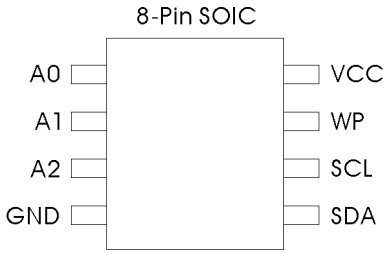
  -2.7 (V CC = 2.7V to 5.5V)

  -2.5 (V CC = 2.5V to 5.5V)

  -1.8 (V CC = 1.8V to 5.5V)

- Internally Organized 128 x 8 (1K), 256 x 8 (2K), 512 x 8 (4K), 1024 x 8 (8K) or 2048 x 8 (16K)
- 2-Wire Serial Interface
- Schmitt Trigger, Filtered Inputs for Noise Suppression
- Bi-directional Data Transfer Protocol
- 100 kHz (1.8v, 2.5V, 2.7V) and 400 kHz (5V) Compatibility
- Write Protect Pin for Hardware Data Protection
- 8-Byte Page (1K, 2K), 16-Byte Page (4K, 8K, 16K) Write Modes
- Partial Page Writes Are Allowed
- Self-Timed Write Cycle (10 ms max)
- High Reliability
  - Endurance: 1 Million Write Cycles
  - Data Retention: 100 Years
  - ESD Protection: >3000V
- Automotive Grade and Extended Temperature Devices Available
- 8-Pin and 14-Pin JEDEC SOIC, 8-Pin PDIP, 8-Pin MSOP, and 8-Pin TSSOP Packages

*** Pin Configurations**



*** Pin Description**

Pin Name	Function
A0-A2	Address Inputs
SDA	Serial Data
SCL	Serial Clock input
WP	Write Protect
NC	No Connect

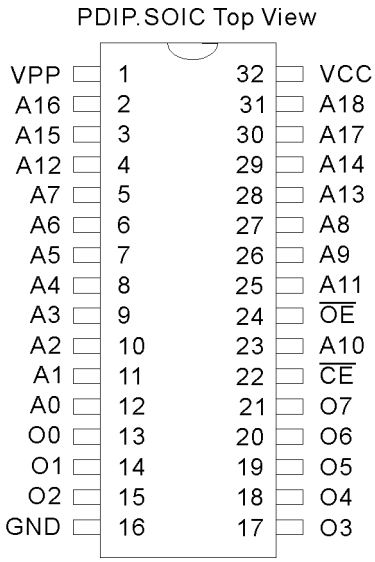
2-1-6 4-Megabit (512 x 8) FLASH RAM (MX29F040)

*** Features**

- Fast Read Access Time – 70 ns
- Low power CMOS Operation
  -100 µA max. Standby
  -30 µA max. Active at 5 MHz
- JEDEC Standard Packages
- High Reliability CMOS Technology
  -2000V ESD Protection
  -200 mA Latchup Immunity
- Rapid™ Programming Algorithm – 100 µs/byte (typical)
- CMOS and TTL Compatible Inputs and Outputs

- Integrated Product Identification Code
- Commercial and Industrial Temperature Ranges

*** Pin Configurations**



*** Pin Description**

Pin Name	Function
A0 – A18	Addresses
O0 – O7	Outputs
CE#	Chip Enable
OE#	Output Enable

*** Absolute Maximum Ratings**

Temperature Under Bias…….-55°C to + 125 °C
Storage Temperature……...-65 °C to + 150 °C
Voltage on Any Pin with Respect to Ground……..-2.0V to + 7.0V
Voltage on A9 with Respect to Ground……...-2.0V to + 14.0V
V PP Supply Voltage with Respect to Ground…….-2.0V to + 14.0V

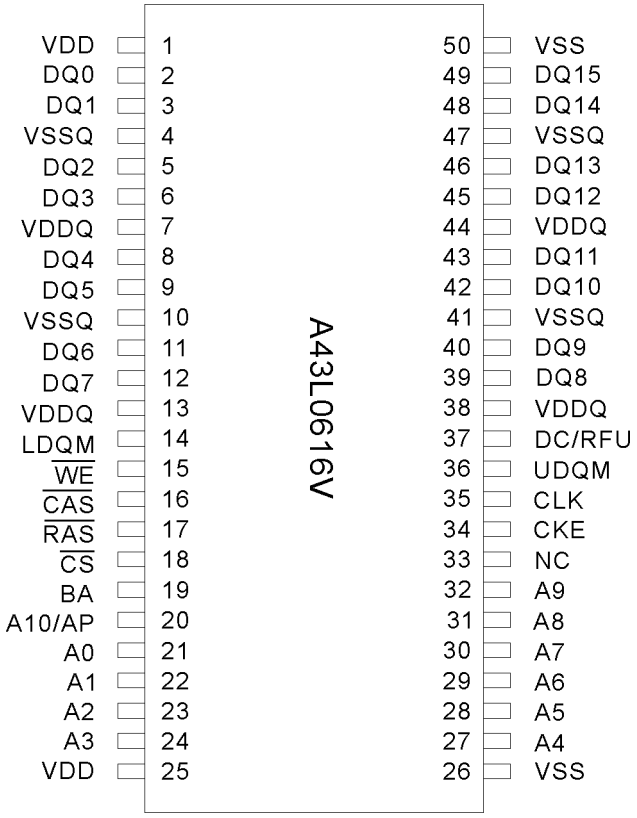
2-1-7 512K X 16 Bit X 2 Banks Synchronous DRAM (A43L0616)

Features

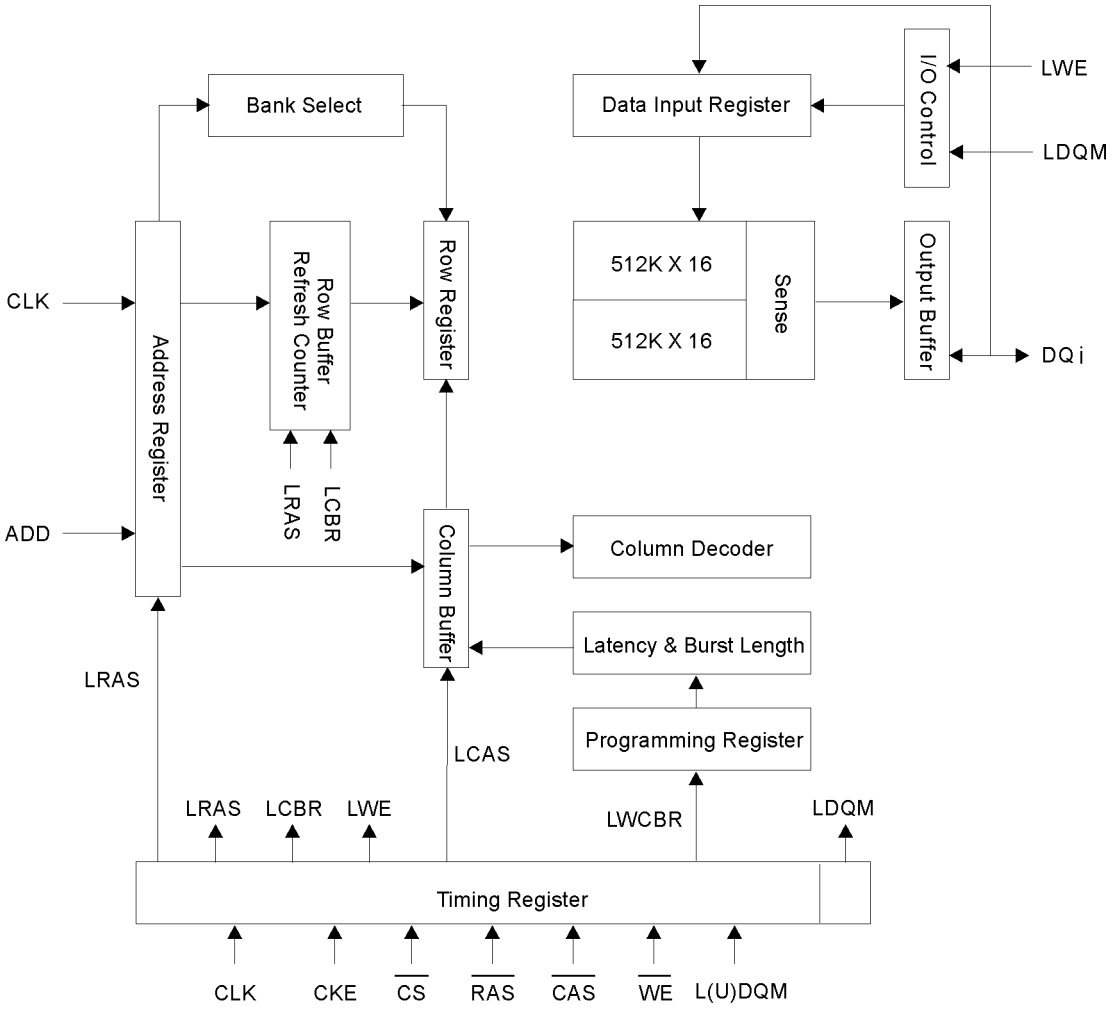
- JEDEC standard 3.3V power supply
- LVTTL compatible with multiplexed address
- Dual banks / Pulse RAS
- MRS cycle with address key programs
  - CAS Latency (2,3)
  - Burst Length (1,2,4,8 & full page)
  - Burst Type (Sequential & interleave)

- All inputs are sampled at the positive going edge of the system clock
- Burst Read Single-bit Write operation
- DQM for masking
- Auto & self refresh
- 64ms refresh period (4K cycle)
- 50 Pin TSOP (II)

Pin Configuration



Block Diagram



Pin Descriptions

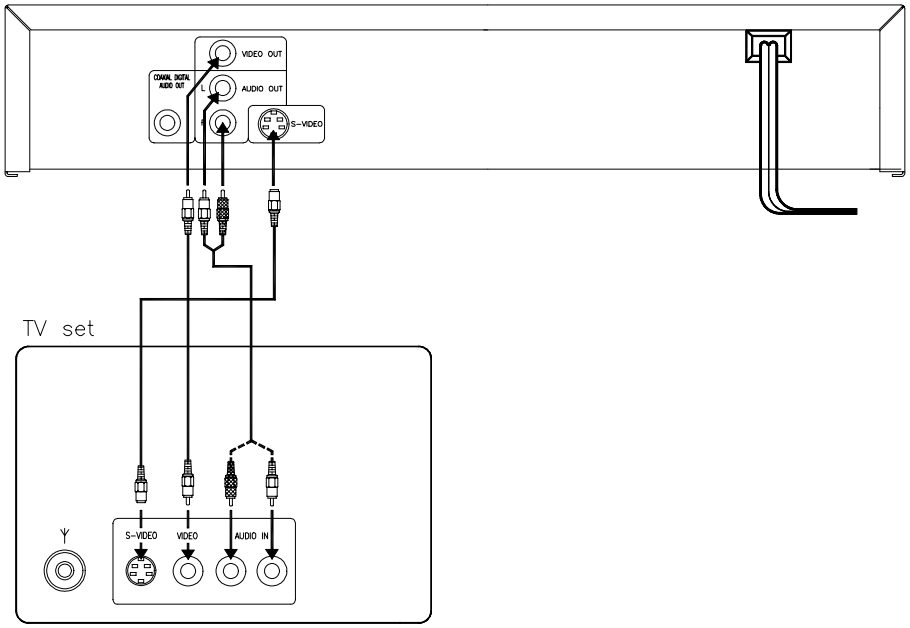
Symbol	Name	Description
CLk	System Clock	Active on the positive going edge to sample all inputs
CS	Chip Select	Disables or Enables device operation by masking or enabling all inputs except CLK, CKE and L(U)DQM
CKE	Clock Enable	Masks system clock to freeze operation from the next clock cycle. CKE should be enabled at least one clock + tss prior to new command. Disable input buffers for power down in standby.
A0~A10/AP	Address	Row/Column addresses are multiplexed on the same pins. Row address: RA0 ~ RA10, Column address: CA0 ~ CA7
BA	Bank Select Address	Selects bank to be activated during row address latch time. Selects band for read/write during column address latch time.
RAS	Row address Strobe	Latches row addresses on the positive going edge of the CLK with RAS low. Enables row access & precharge.
CAS	Column Address Strobe	Latches column addresses on the positive going edge of the CLK with CAS low. Enables column access.
WE	Write Enable	Enables write operation and Row precharge.

Symbol	Name	Description
L(U)DQM	Data Input/Output Mask	Makes data output Hi-Z, t SHZ after the clock and masks the output. Blocks data input when L(U)DQM active.
DW0-15	Data Input/Output	Data inputs/outputs are multiplexed on the same pins.
VDD/VSS	Power Supply/Ground	Power Supply: +3.3V±0.3V/Ground
VDDQ/VSSQ	Data Output Power/Ground	Provide isolated Power/Ground to DQs for improved noise immunity.
NC/RFU	No Connection	

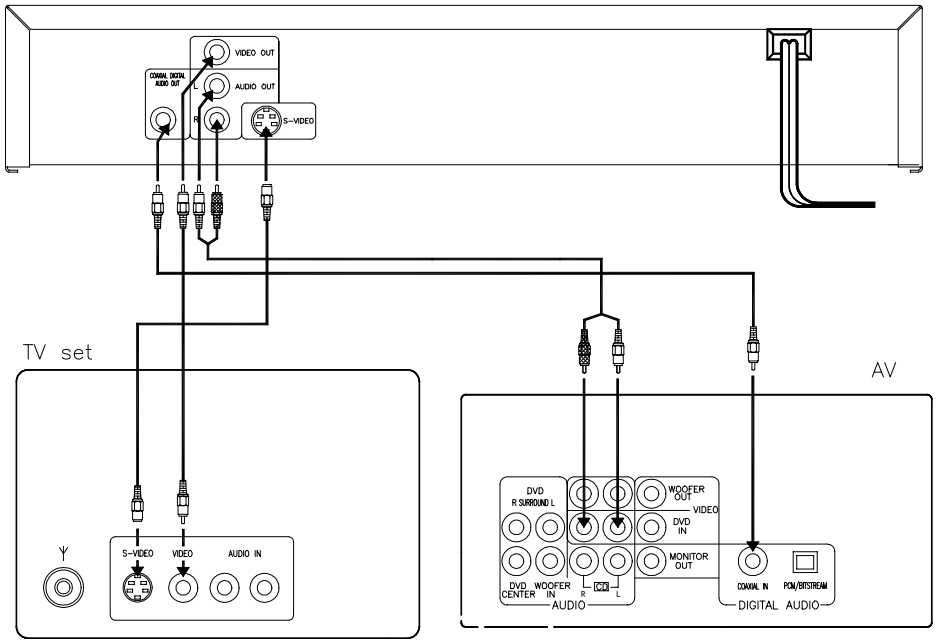
3. Operating Instructions

3-1 Basic Connections

*** CONNECTED TO A TV**



*** CONNECTED TO AN ORDINARY AMPLIFIER**



3-2 Selecting Video MODE

Press SETUP button and select GENERAL SETUP submenu on SETUP screen. After that, select TV TYPE by pressing DOWN arrow button (▼) until desired TV mode is selected. For more information, refer to Page 34-36 on the Instruction Manual.

3-3 Selecting the desired DVD menu Item

Some DVDs have title menus and chapter menus. Press MENU or TITLE,the screen shows the menu.Then use direction buttons to select the desired item,press PLAY.

3-4 Selecting the desired MP3 folder

Use arrow button to select the folder you want to play. Then by pressing the PLAY button ,you can see the the file lists under the folder.

Example:

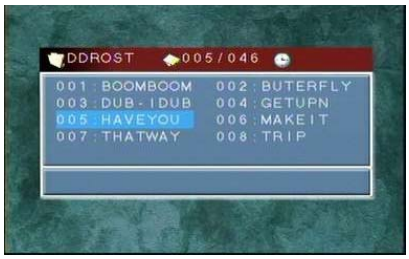
Press the PLAY button

3-5 Selecting the desired MP3 title

Use arrow button and select an MP3 title using the PLAY button then play will start automatically. When you know the title number, enter the MP3 title number using numeric buttons on the remoter control and press the PLAY button. If you want to play an adjacent MP3 title, press the NEXT button for next title and the PREV button for previous title during playing. To select “005 HAVEYOU” MP3 title in this case, press the DOWN arrow button twice and press the PLAY button.

Example:

1. Press the DOWN arrow button (▼)
2. Press the DOWN arrow button (▼)
3. Press the SELECT button



3-6 Searching

When you want to view the disc contents in fast farward or fast reverse, you can do that by pressing FF button (⏩) or FR button (⏪). When playing DVD,there are five choices for both directions:FAST2X, FAST4X, FAST8X, FAST16X FAST32X.When playing SUPER-VCD or VCD, four choices for both directions:FAST1X, :FAST2X, :FAST3X, :FAST4X. When playing CD.MP3,press ⏩ to play forward fast and ⏪ to reverse the disc.

3-7 Resume Play

The unit can memorize the last point where it stops and resume playback from there. While playing CD,MP3,press STOP to stop playing and then press MEMORY to resume playback. However, this function does not work for any programmed playback ;it is removed when the disc is unloaded or the unit is off.

3-8 Slow Viewing

When you want to view the disc contents very slowly in forward or reverse direction, you can do that by pressing the SLOW button. When playing DVD,there are six choices:SF2X, SF4X, SF8X, SR2X, SR4X, SR8X. While playing SUPER-VCD OR VCD,there are three choices: SF1x, SF2x, SF3x.Take DVD for example, to view at slow 2x in reverse direction ,press the slow buttom four times. To resume playing normally ,just press PLAY.

3-9 Selecting Audio Language

This function works only with discs on which multiple audio sound track languages are recorded. If the loaded disc supports multiple languages, you can see the AUD indicator on fluorescent display. IN the figure shown right, there are total 8 audio languages. To select the third audio language, press the AUDIO button twice during play.

Example:

1. Press the AUDIO button
2. Press the AUDIO button

3-10 Selecting Subtitle Language

This function works only with discs on which multiple subtitle languages are recorded. If the loaded disc supports multiple languages, you can see the SUB-T indicator on fluorescent display, In the figure shown right, there is only one subtitle language. To turn on the subtitle language, press the SUBTITLE button. If you press it again, you can turn off the subtitle language.

Example:

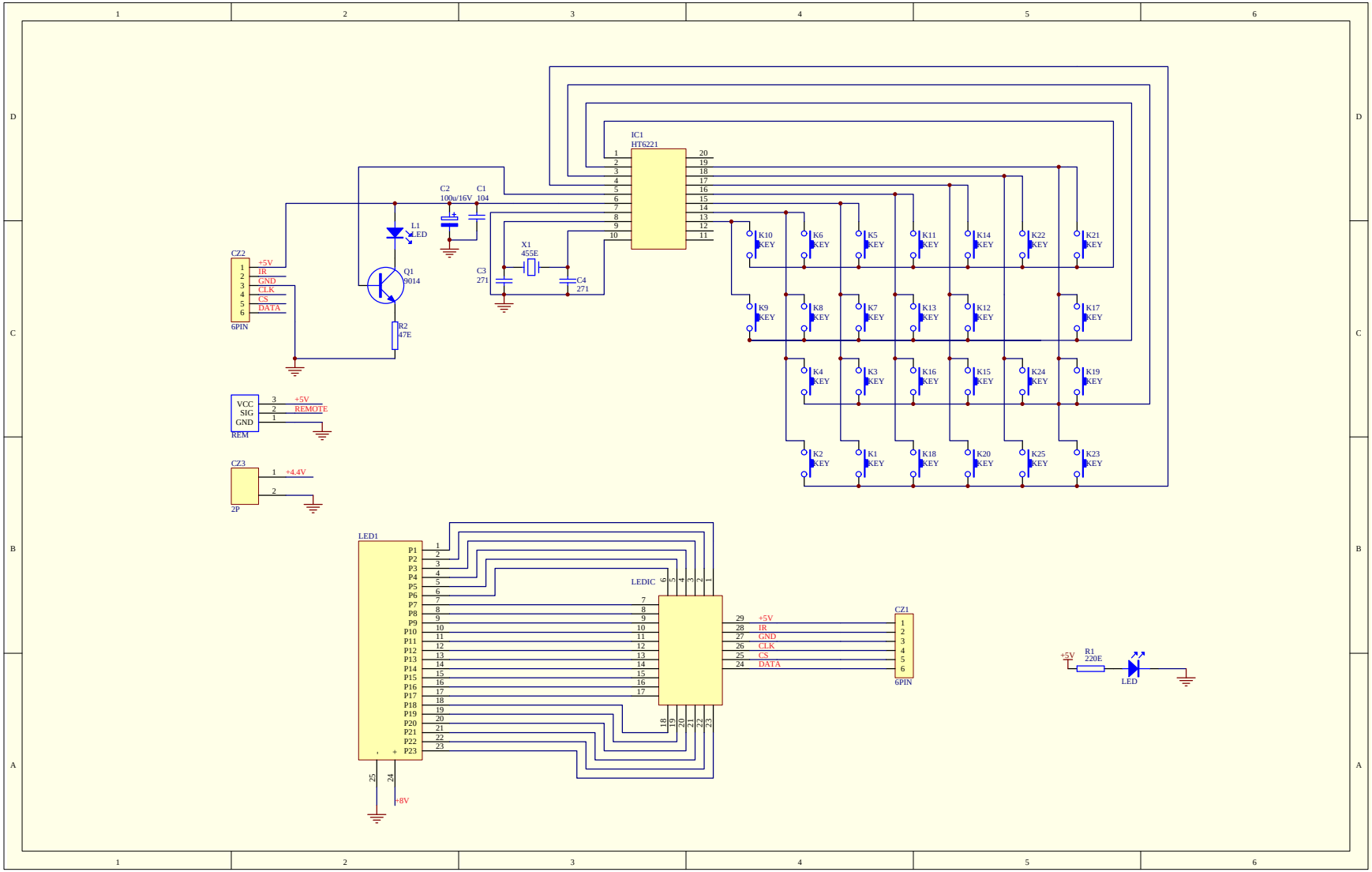
1. Press the SUBTITLE button

3-11 Selecting Angle

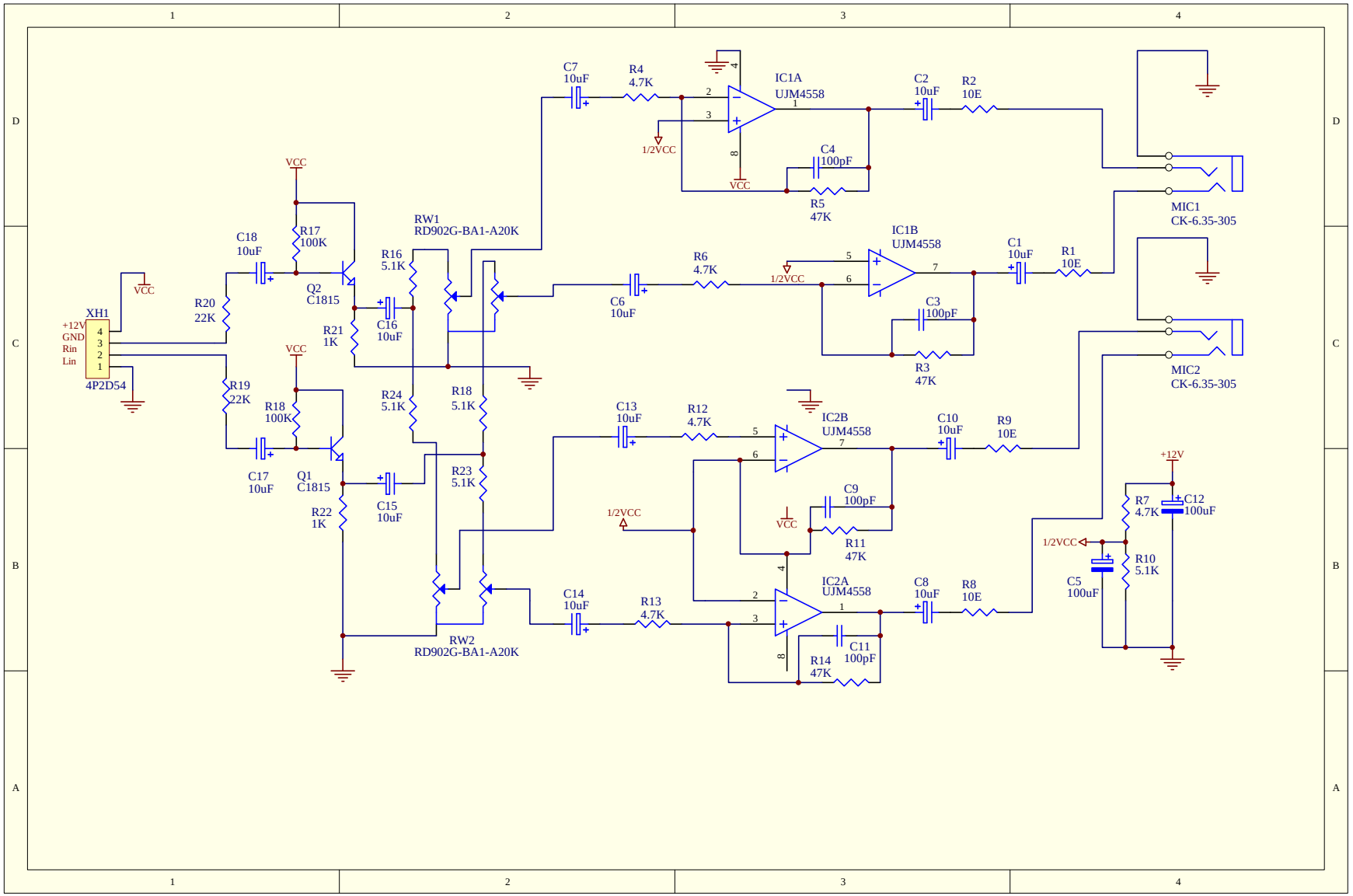
Some DVD discs may contain scenes, which have shot simultaneously from a number of different angles. If the loaded disc supports multiple angles, you can see indicator on the fluorescent display and the TV screen. In the figure shown right, there are total 4 angles. To switch to the angle number2, press the ANGLE button.

4.Circuit Diagrams

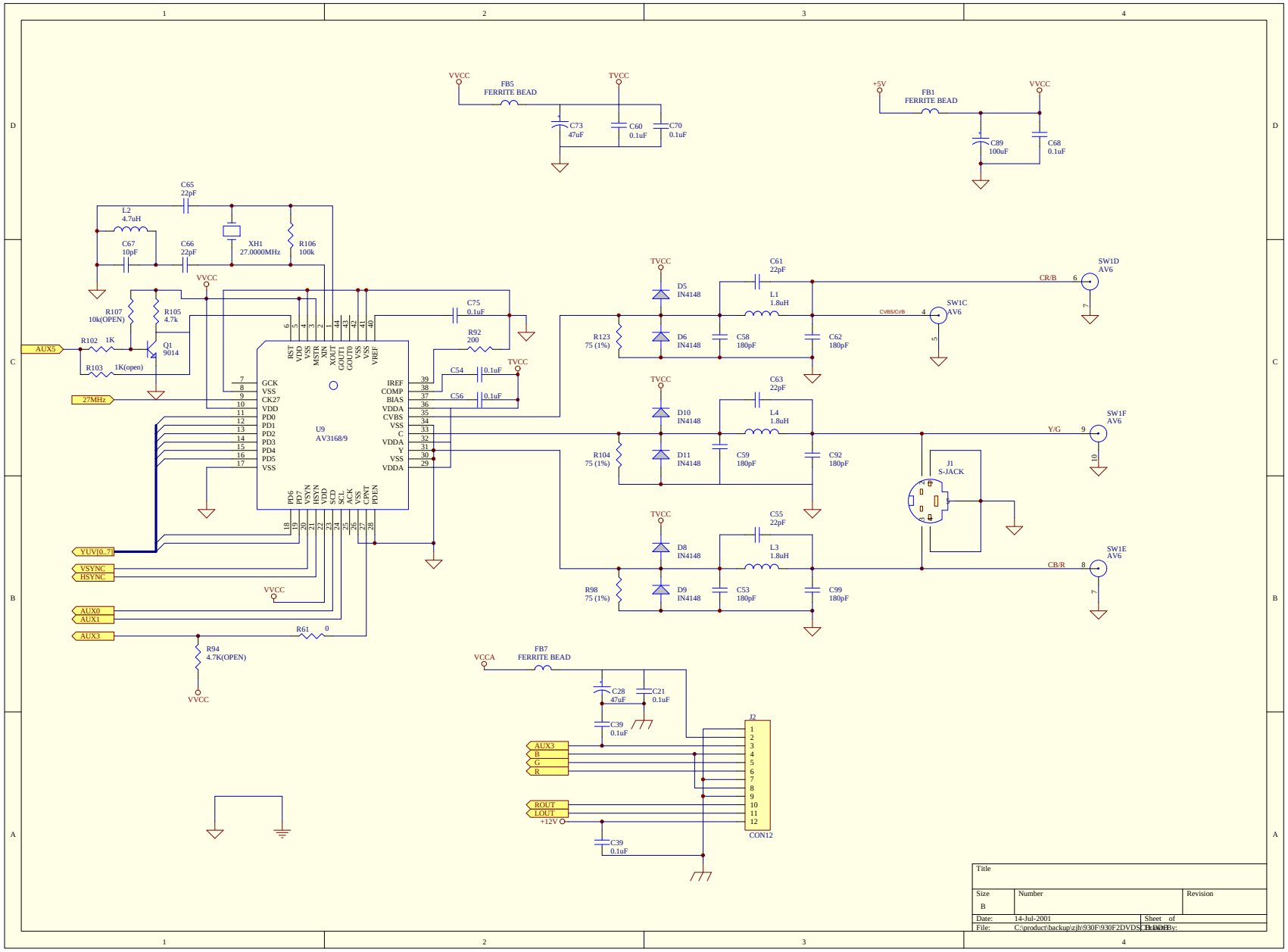
1.Control Part



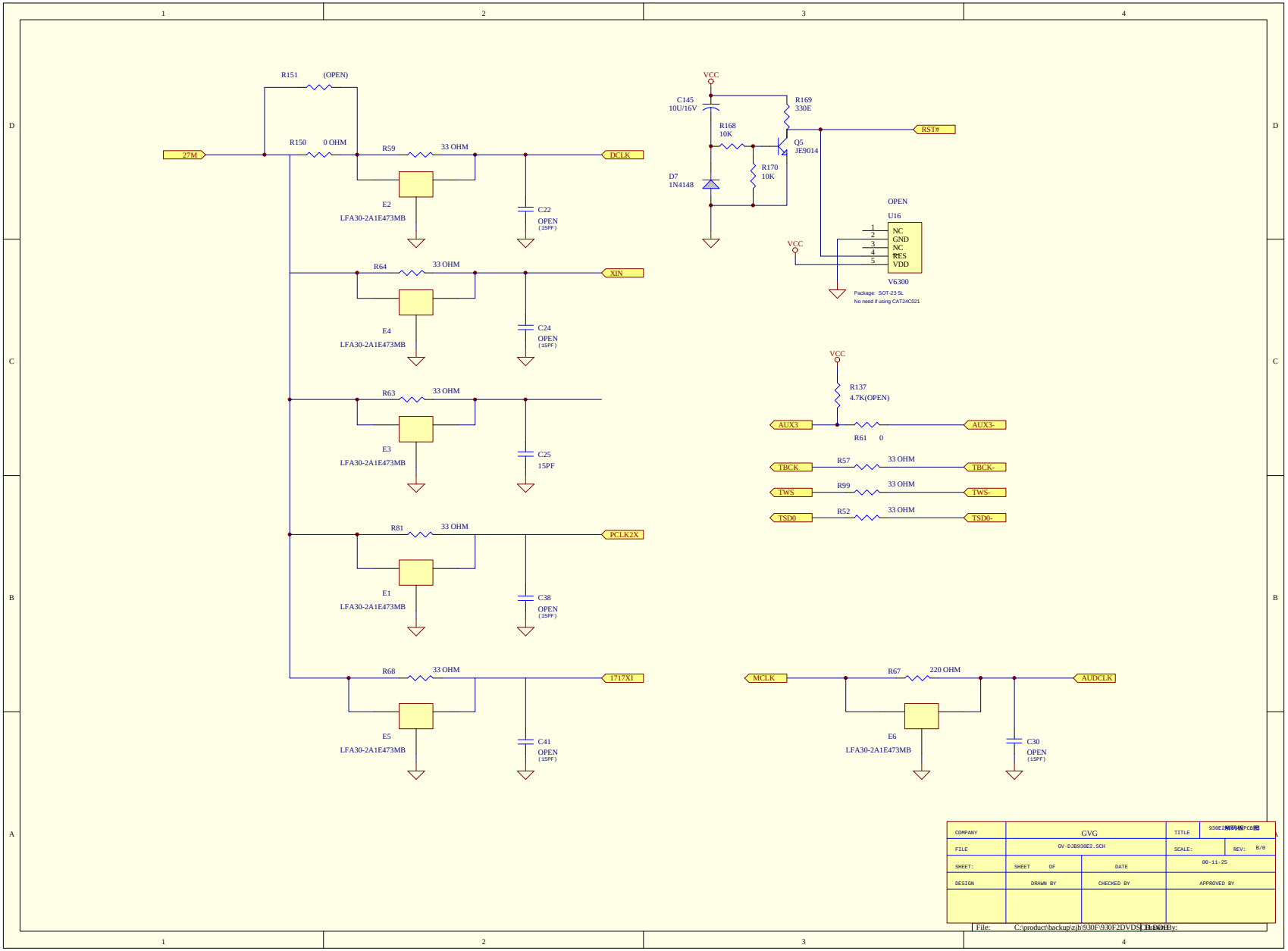
2.Ear Part


XH1
+12V
GND
Rin
Lin
4P2D54
VCC
R20 22K
R19 22K
C18 10uF
R17 100K
Q2 C1815
R18 100K
C17 10uF
Q1 C1815
R22 1K
R21 1K
C16 10uF
C15 10uF
RW1 RD902G-BA1-A20K
RW2 RD902G-BA1-A20K
R16 5.1K
R24 5.1K
R18 5.1K
R23 5.1K
C7 10uF
R4 4.7K
IC1A UJM4558
1/2VCC
C4 100pF
R5 47K
C2 10uF
R2 10E
MIC1 CK-6.35-305
C6 10uF
R6 4.7K
IC1B UJM4558
C3 100pF
R3 47K
C1 10uF
R1 10E
MIC2 CK-6.35-305
C13 10uF
R12 4.7K
IC2B UJM4558
C9 100pF
R11 47K
C10 10uF
R9 10E
C14 10uF
R13 4.7K
IC2A UJM4558
C11 100pF
R14 47K
C8 10uF
R8 10E
+12V
R7 4.7K
C12 100uF
R10 5.1K
C5 100uF

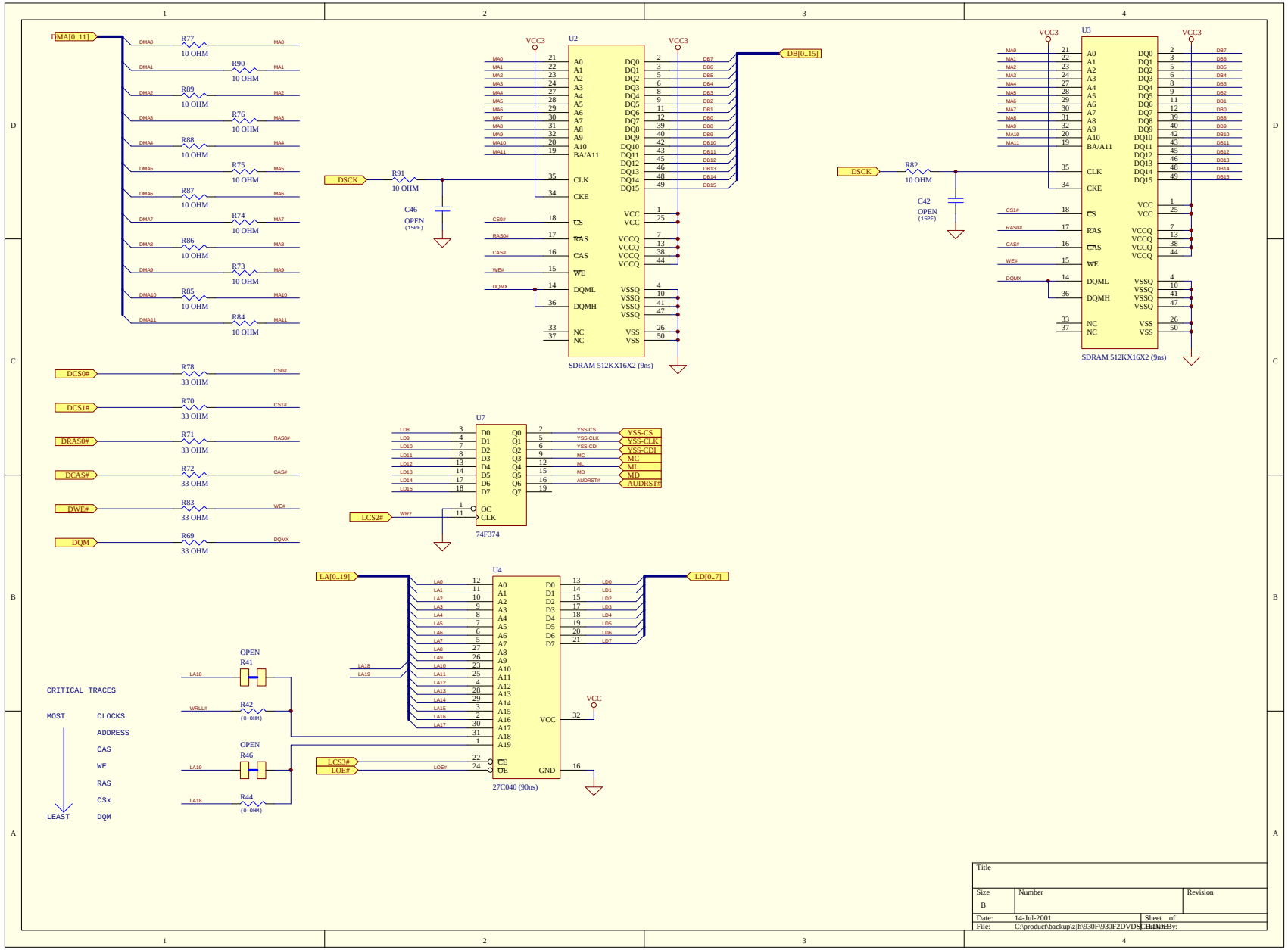
3.Video Part


VVCC
FB5
FERRITE BEAD
TVCC
C73
47uF
C60
0.1uF
C70
0.1uF
+5V
FB1
FERRITE BEAD
VVCC
C89
100uF
C68
0.1uF
C65
22pF
L2
4.7uH
C67
10pF
C66
22pF
XH1
27.0000MHz
R106
100k
VVCC
R107
10k(OPEN)
R105
4.7k
AUX5
R102
1K
Q1
9014
R103
1K(open)
27MHz
C75
0.1uF
R92
200
TVCC
C54
0.1uF
C56
0.1uF
U9
AV3168/9
GCK
VSS
CK27
VDD
PD0
PD1
PD2
PD3
PD4
PD5
VSS
IREF
COMP
BIAS
VDDA
CVBS
VSS
C
VDDA
Y
VSS
VDDA
RST
VDD
VSS
MSTR
XIN
XOUT
GOUT1
GOUT0
VSS
VSS
VREF
PD6
PD7
VSYN
HSYN
VDD
SCL
SCL
ACK
VSS
CPWT
PDSEN
YUV[0..7]
VSYNC
HSYNC
AUX0
AUX1
AUX3
VVCC
R61
0
R94
4.7K(OPEN)
VVCC
TVCC
D5
IN4148
D6
IN4148
C61
22pF
L1
1.8uH
C58
180pF
C62
180pF
R123
75 (1%)
CVBS/CrB
SW1C
AV6
CR/B
SW1D
AV6
TVCC
D10
IN4148
D11
IN4148
C63
22pF
L4
1.8uH
C59
180pF
C92
180pF
R104
75 (1%)
Y/G
SW1F
AV6
J1
S-JACK
TVCC
D8
IN4148
D9
IN4148
C55
22pF
L3
1.8uH
C53
180pF
C99
180pF
R98
75 (1%)
CB/R
SW1E
AV6
VCCA
FB7
FERRITE BEAD
C28
47uF
C21
0.1uF
C39
0.1uF
AUX3
B
G
R
ROUT
LOUT
+12V
C39
0.1uF
J2
CON12
Title
Size
B
Number
Revision
Date:
14-Jul-2001
Sheet of
File:
C:\product\backup\zjh\930F\930F2DVDS.DDB
Drawn By:

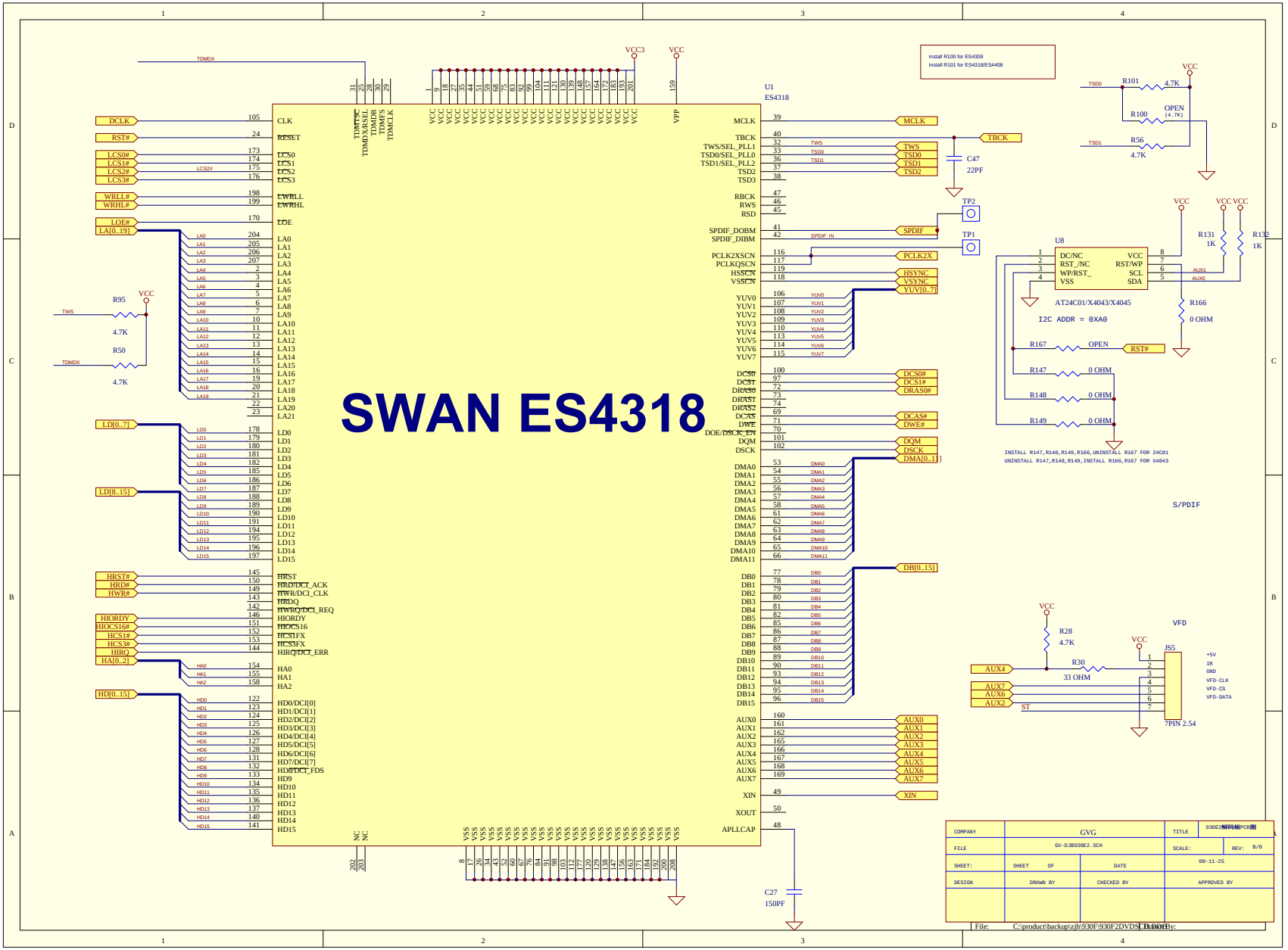
4.Clock Part


R151 (OPEN)
27M
R150 0 OHM
R59 33 OHM
DCLK
E2
LFA30-2A1E473MB
C22
OPEN
(15PF)
R64 33 OHM
XIN
E4
LFA30-2A1E473MB
C24
OPEN
(15PF)
R63 33 OHM
E3
LFA30-2A1E473MB
C25
15PF
R81 33 OHM
PCLK2X
E1
LFA30-2A1E473MB
C38
OPEN
(15PF)
R68 33 OHM
1717XI
E5
LFA30-2A1E473MB
C41
OPEN
(15PF)
VCC
C145
10U/16V
R169
330E
R168
10K
Q5
JE9014
RST#
D7
1N4148
R170
10K
OPEN
U16
NC
GND
NC
RES
VDD
V6300
Package: SOT-23 5L
No need if using CAT24C021
VCC
R137
4.7K(OPEN)
AUX3
AUX3-
R61 0
TBCK
R57 33 OHM
TBCK-
TWS
R99 33 OHM
TWS-
TSD0
R52 33 OHM
TSD0-
MCLK
R67 220 OHM
AUDCLK
E6
LFA30-2A1E473MB
C30
OPEN
(15PF)
COMPANY
GVG
TITLE
FILE
GV-DJ8930E2.SCH
SCALE:
REV: B/0
SHEET:
SHEET OF
DATE
00-11-25
DESIGN
DRAWN BY
CHECKED BY
APPROVED BY
File: C:\product\backup\zjh\930F\930F2DVDS
Drawn By:

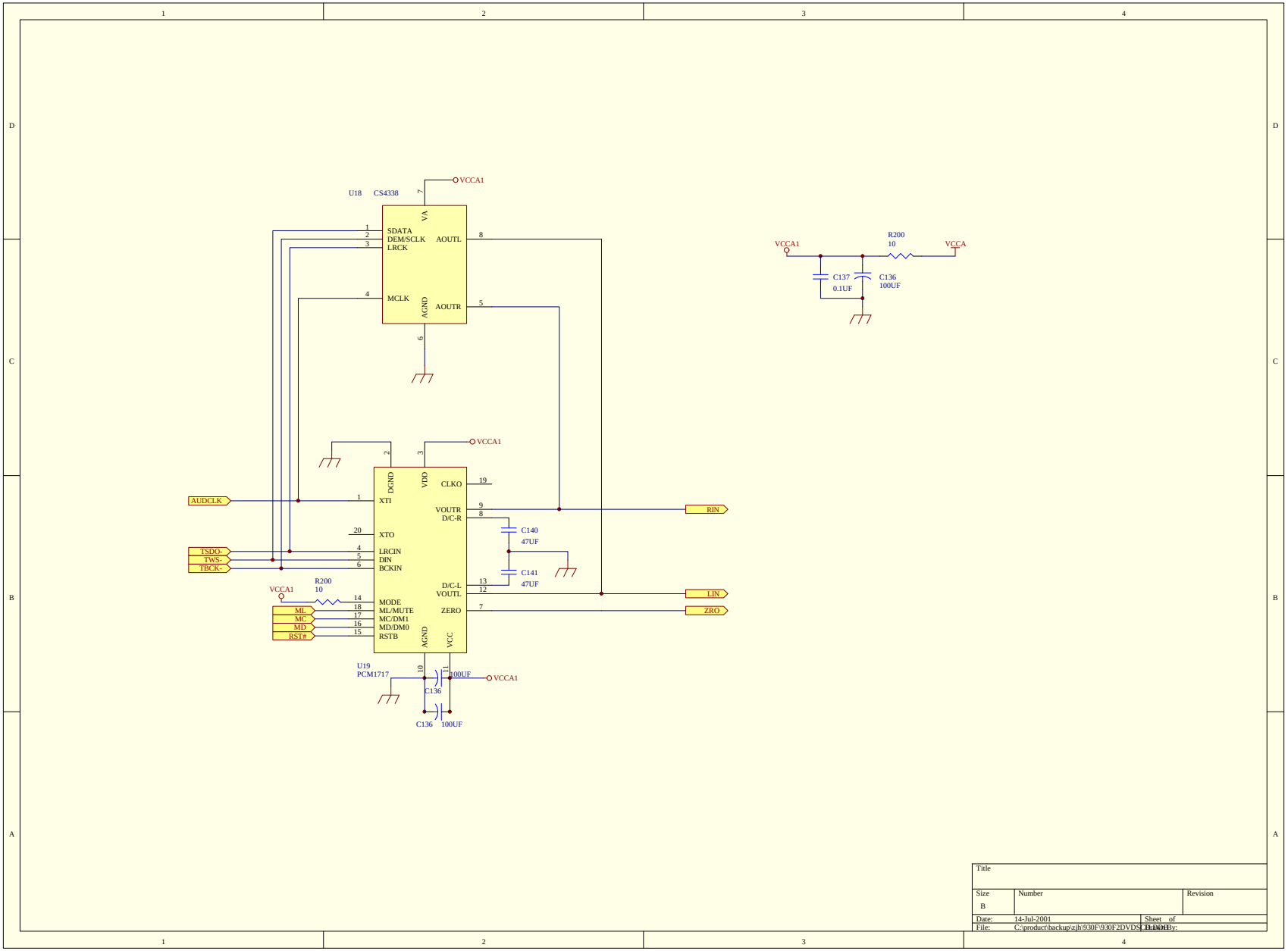
5.Memory Part



6.Chip 4318

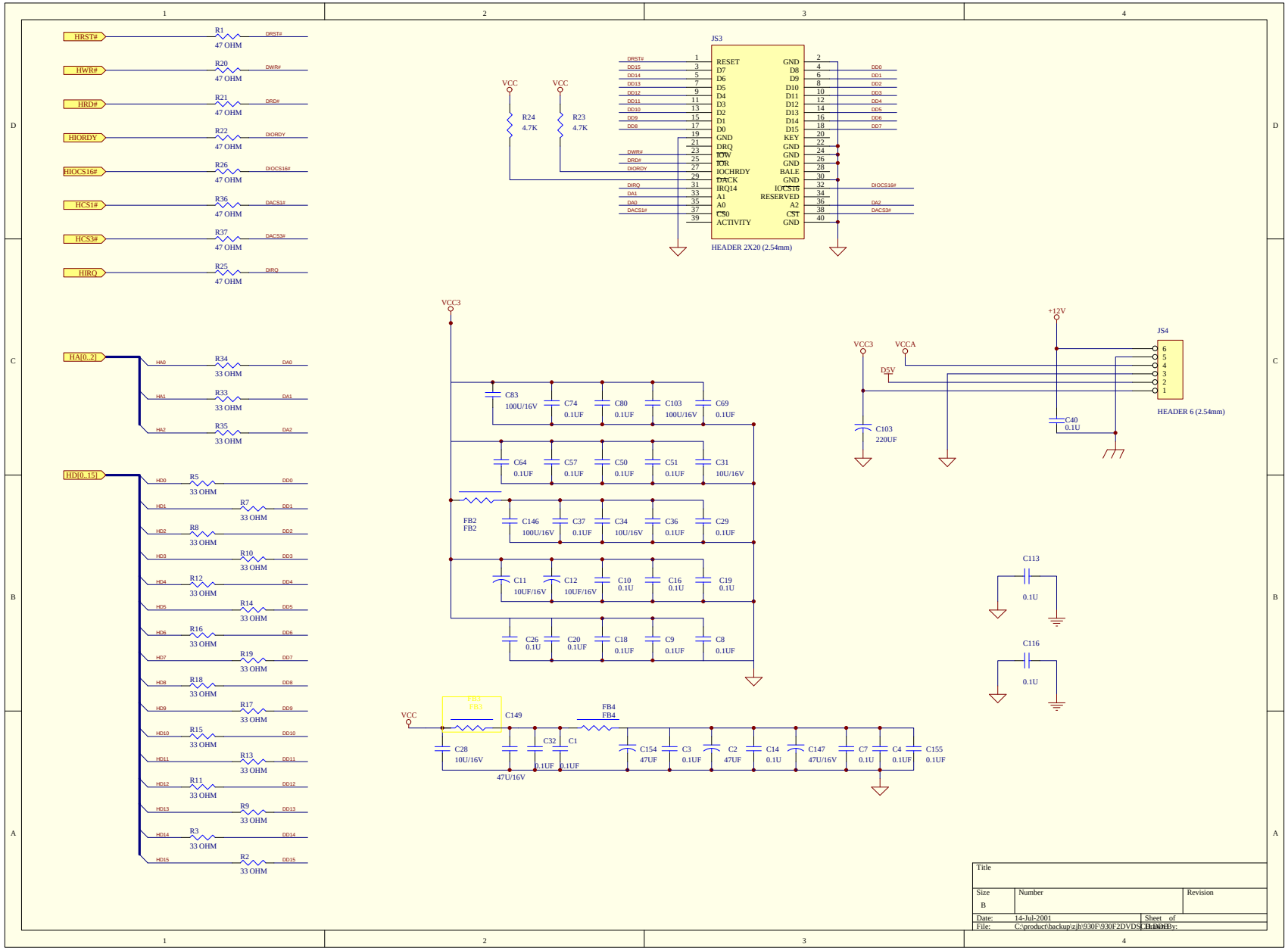

SWAN ES4318
U1
ES4318
Install R100 for ES4308
Install R101 for ES4318/ES4408
U8
AT24C01/X4043/X4045
I2C ADDR = 0XA0
INSTALL R147,R148,R149,R166,UNINSTALL R167 FOR 24C01
UNINSTALL R147,R148,R149,INSTALL R166,R167 FOR X4043
S/PDIF
VFD
7PIN 2.54
COMPANY
GVG
FILE
GV-DJ8930E2.SCH
SHEET:
DESIGN
DRAWN BY
CHECKED BY
APPROVED BY
DATE
00-11-25
File: C:\product\backup\zjh\930F\930F2DVDS[1].DDB

7.D/A Converter Part

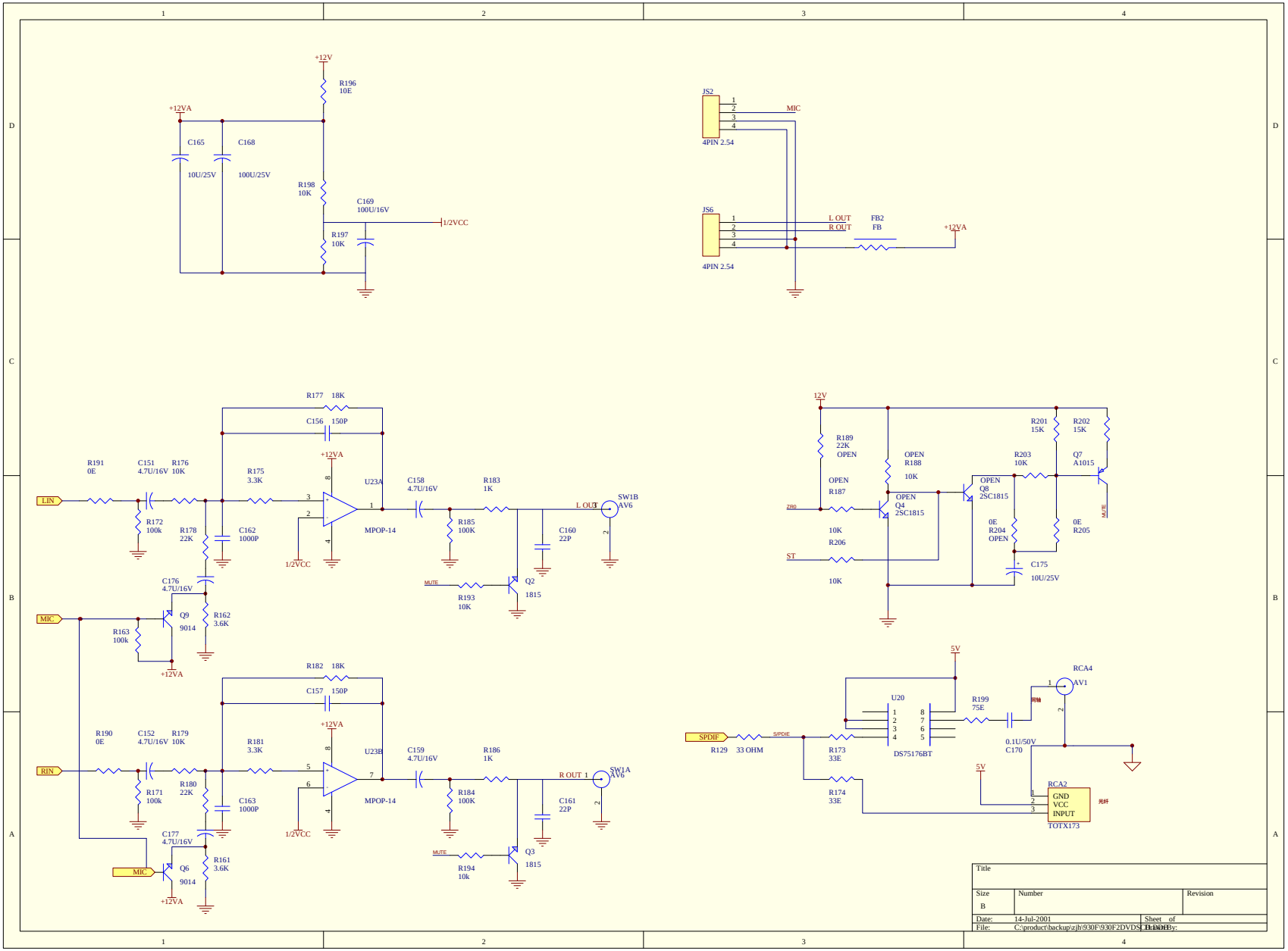


Title		
Size B	Number	Revision
Date: 14-Jul-2001	Sheet of	
File: C:\product\backup\zjh\930F\930F2DVDS.ddb	Drawn By:	

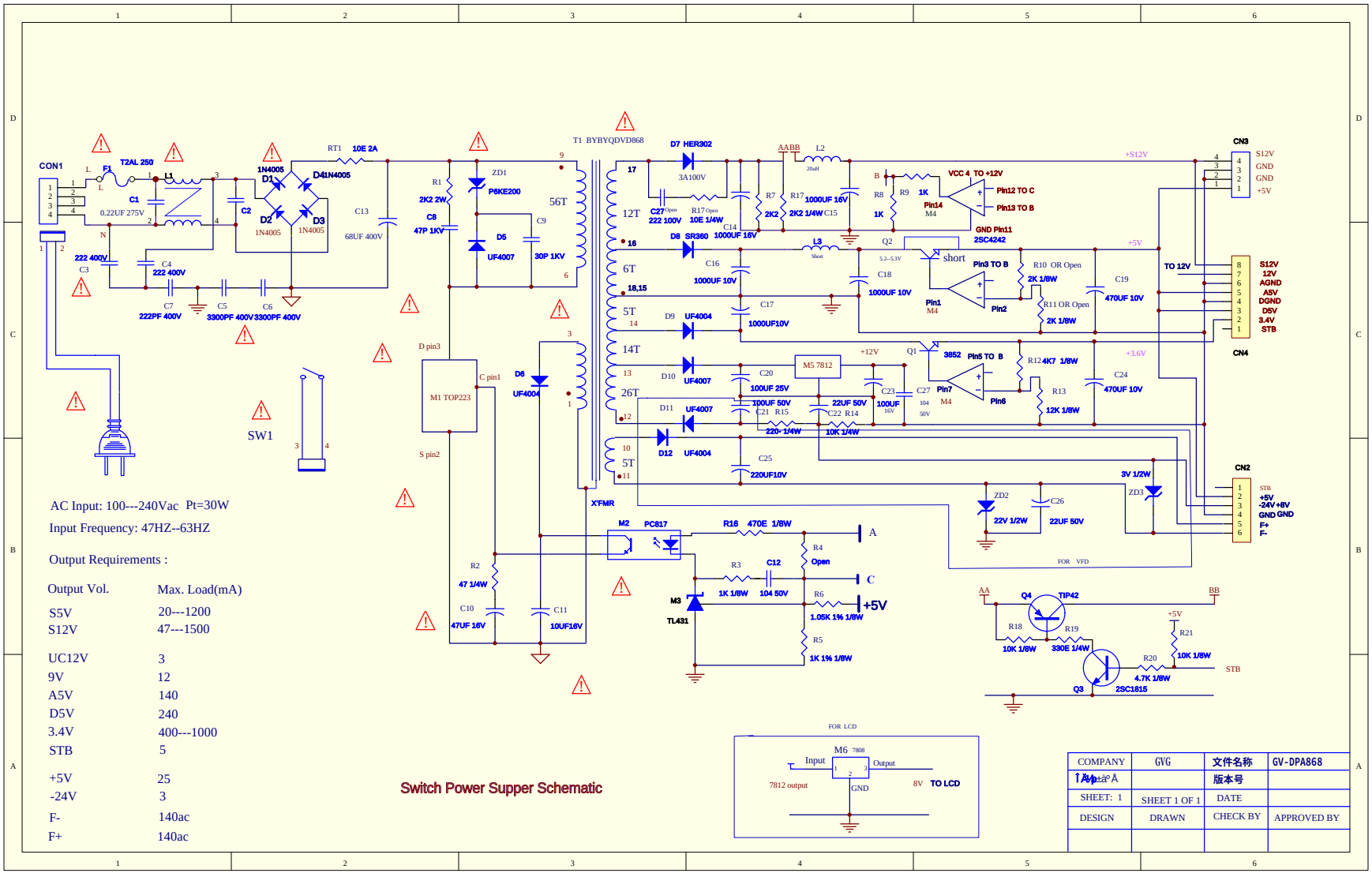
8.Atapi Part


HRST#
HWR#
HRD#
HIORDY
HIOCS16#
HCS1#
HCS3#
HIRQ
47 OHM
HA[0..2]
HD[0..15]
33 OHM
JS3
HEADER 2X20 (2.54mm)
VCC
VCC3
VCCA
+12V
D5V
JS4
HEADER 6 (2.54mm)
FB2
FB3
FB4
C83
C74
C80
C103
C69
C64
C57
C50
C51
C31
C146
C37
C34
C36
C29
C11
C12
C10
C16
C19
C26
C20
C18
C9
C8
C28
C32
C1
C154
C3
C2
C14
C147
C7
C4
C155
C149
C40
C103
C113
C116
Title
Size
B
Number
Revision
Date:
14-Jul-2001
Sheet of
File:
C:\product\backup\zjh\930F\930F2DVDS.ddb
Drawn By:

9.Audio Part


+12V
R196 10E
+12VA
C165 10U/25V
C168 100U/25V
R198 10K
C169 100U/16V
1/2VCC
R197 10K
JS2
4PIN 2.54
MIC
JS6
4PIN 2.54
L OUT
R OUT
FB2
FB
+12VA
R177 18K
C156 150P
R191 0E
C151 4.7U/16V
R176 10K
R175 3.3K
U23A
C158 4.7U/16V
R183 1K
LIN
R172 100k
R178 22K
C162 1000P
MPOP-14
R185 100K
C160 22P
L OUT 3
SW1B AV6
C176 4.7U/16V
MIC
Q9 9014
R162 3.6K
R163 100k
MUTE
R193 10K
Q2 1815
R182 18K
C157 150P
R190 0E
C152 4.7U/16V
R179 10K
R181 3.3K
U23B
C159 4.7U/16V
R186 1K
RIN
R171 100k
R180 22K
C163 1000P
MPOP-14
R184 100K
C161 22P
R OUT 1
SW1A AV6
C177 4.7U/16V
MIC
Q6 9014
R161 3.6K
MUTE
R194 10k
Q3 1815
12V
R189 22K OPEN
OPEN R187
OPEN R188 10K
OPEN Q4 2SC1815
OPEN Q8 2SC1815
R201 15K
R202 15K
R203 10K
Q7 A1015
ZRO
10K R206
ST
10K
0E R204 OPEN
0E R205
C175 10U/25V
5V
U20
DS75176BT
R199 75E
RCA4
AV1
SPDIF
R129 33 OHM
SPDIE
R173 33E
R174 33E
0.1U/50V C170
5V
RCA2
GND
VCC
INPUT
TOTX173
Title
Size B
Number
Revision
Date: 14-Jul-2001
Sheet of
File: C:\product\backup\zjh\930F\930F2DVDS.ddb
Drawn By:

10.Power Part



5. Troubleshooting

No power	Insert the AC power plug securely into the power outlet.
No picture	Make sure that the equipment is connected properly. Make sure that the input setting for TV is Video (AV).
No sound	Make sure that the equipment is connected properly.
Distorted sound	Make sure that the input settings for the TV and stereo system are correct.
No fast forward or fast reverse	Some discs may have sections that prohibit fast forward or fast reverse.
No proper aspect ratio	Select the correct setup for TV aspect ratio that matches your TV set.
No operations can be performed with the remote controller	Check the batteries are installed with the correct polarities. Point the remote control unit at the remote control sensor and operate. Remove the obstacles between the remote control unit and remote control sensor.
No button operation	Set the POWER button to OFF and then back to ON. Alternatively, turn off the power, disconnect the power plug and then reconnect it.
Audio soundtrack and/or Subtitle language is not the one you selected.	If the audio soundtrack and /or subtitle language does not exist on the disc, the language selected at the initial settings will not be seen.
No Angle change	This function is dependent on software availability. Even if a disc has a number of angles recorded, these angles may be recorded for specific scenes only.